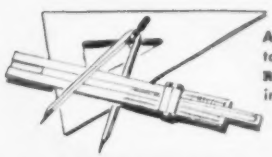
the EXPLORATION ISSUE
...SPECIAL GRAVITY INSERT MAP

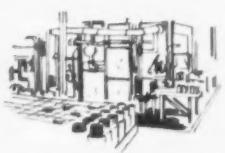
# OIL AND GAS JOURNAL

There is more than meets the eye.. ..in REED TOOL JOINTS



**Advanced design.** The list of **REED** tool joint developments is assurance that **REED** Tool Joints contain all the latest improvements in design.

**Precision heat treatment** in these modern furnaces gives every **REED** Tool Joint the right combination of toughness and wear resistance.



**120 separate inspections** assure uniform high quality of every **REED** Tool Joint — minimizing the chance of premature failure.

You can't see the expensive alloys and the "tailored" heat treatment that help make **REED** Tool Joints last longer. Nor can you see the experience and integrity of the organization that stands behind every **REED** Tool Joint.

You *can* see the fine surface finish on the shoulder, and the pre-lubrication infused into the threads. You can see the **REED** "Mark of Quality" inspectors stamp.

Whether you can see the difference or not, you can be sure that **REED** Tool Joints will last longer on your rigs.

**REED makes all kinds of tool joint connections—**
**Super Shrink-Grip • Counterbore Weld • Flash Welded to Drill Pipe**

**REED ROLLER BIT COMPANY**
HOUSTON 1, TEXAS

THE MARK OF QUALITY

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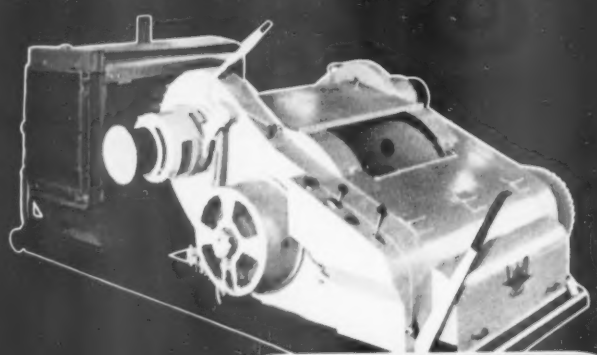
1,000,000 feet of hole has been drilled by the first UNIT U-34 . . . and it's STILL drilling.

ENDURANCE is built into this little rig with big rig performance with . . .

- . . . hydraulic torque converter providing wide range of speed, maximum obtainable horsepower, smooth operation and elimination of shock loads.
- . . . one lever clutch and throttle control promoting fast, safe operation.
- . . . built in hydromatic brake with automatic declutching arrangement.
- . . . skid or trailer mounted for ease of handling and transporting.
- . . . minimum of upkeep required. Few adjustments are ever necessary.

The UNIT U-34, with ENDURANCE built in, is designed for economical drilling from 1,500 to 4,500 feet.

Buy a Rig with ENDURANCE . . . Buy a UNIT U-34.



U-34

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TULSA, OKLAHOMA U.S.A.

DESIGNED FOR THE JOB....

U-35

U-15

U-40

U-20

U-30

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the OIL AND GAS JOURNAL

APRIL 19, 1954 VOL. 52 NO. 50

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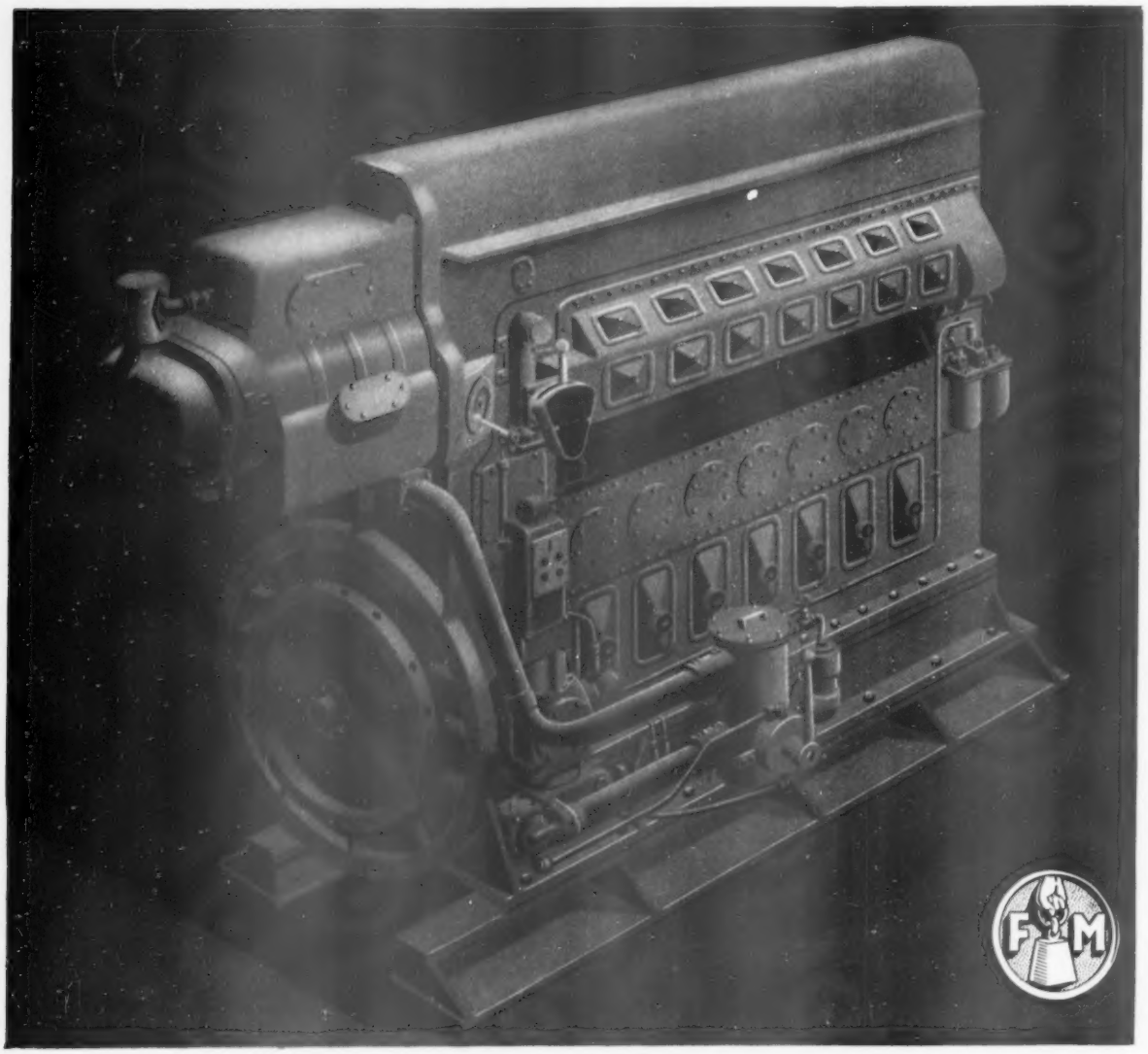
## In Brief . . .

The annual exploration section of this issue spotlights two features:

• Lester Logue's article relates the regional gravity of the Mid-Continent geologic structure. Emphasis is placed upon gravity data as a valuable tool for the geologists. Regional structural features are related to major periods of movement. The various maps on the large insert map illustrate the discussion.

• The geophysical symposium treats the problem of improving record quality by pattern shooting and multiple geophones. Proper spacing of multiple geophones or pattern shooting helps eliminate random noise and produces usable records in areas previously considered "unshootable." The slight increase in cost of seismic exploration using these methods is more than offset by the added data and subsequent reduction in leasing and drilling costs.

In addition to these two features are other articles related to the ceaseless search for new oil reserves—some standard in this annual issue, and others new.



The Fairbanks-Morse Opposed Piston Diesel Model 38F 90. 225 to 750 horsepower. Diesel, Dual Fuel and Spark-ignition options. Other O-P engines available in horsepower ratings to 2400.

# *Some engines are not good enough*

Yes, there are some diesels which just do not have what it takes for the job. They cannot satisfy the owner's pride in smooth, trouble-free operation and are lacking in the ability to square a balance sheet of operational costs and profits. For the more difficult jobs, many engines are simply not good enough.

Maybe you should pay more and get more!

If you want more engine-hours with fewer man-hours, *then* you should have the F-M Opposed Piston Diesel which will cost a little more and give you much, *much* more.

Fairbanks, Morse & Co., Chicago 5, Illinois.

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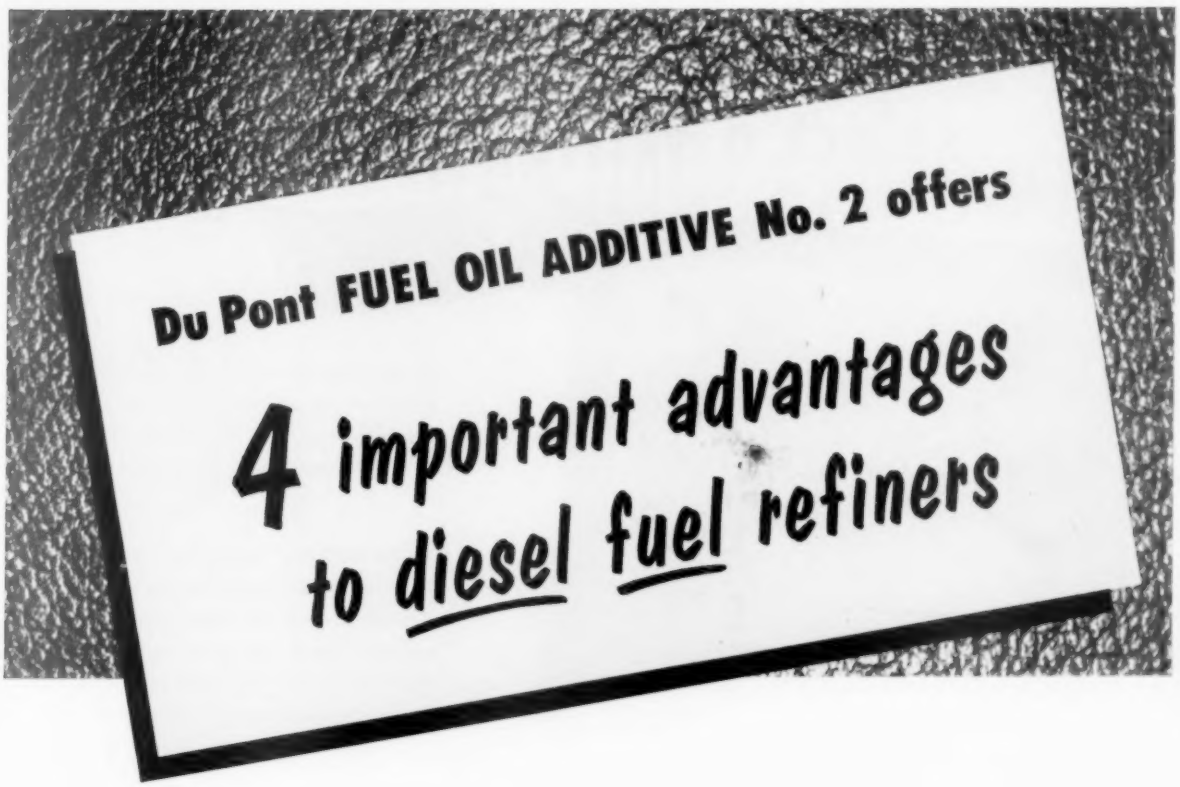
***a name worth remembering when you want the best***

DIESEL AND DUAL FUEL ENGINES • DIESEL LOCOMOTIVES • RAIL CARS • ELECTRICAL MACHINERY • PUMPS • SCALES • HOME WATER SERVICE EQUIPMENT • FARM MACHINERY • MAGNETOS




**1. Leaves no deposits**

Being ashless, Du Pont Fuel Oil Additive No. 2 leaves no combustion chamber deposits to cause operating difficulties.

**2. Gives added flexibility**

To help you gain added flexibility and capacity in diesel fuel production, Fuel Oil Additive No. 2 enables you to blend cat-cracked and straight-run stocks, without sacrificing stability in the blend.

**3. Upgrades heavy oils**

This additive can help you upgrade your heavy distillate fuel oils because it allows a certain amount of these heavy oils to be blended in the diesel fuel without affecting filterability.

**4. Prevents clogging**

Du Pont Fuel Oil Additive No. 2 not only retards the formation of insoluble residues, but also reduces the particle size of those insoluble residues that are formed and thus reduces clogging of diesel filter screens. Highly concentrated, Fuel Oil Additive No. 2 will produce desired results at the lowest possible cost.

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Free samples and more detailed information on Fuel Oil Additive No. 2 are available from any Du Pont Petroleum Chemicals Division representative or regional office.

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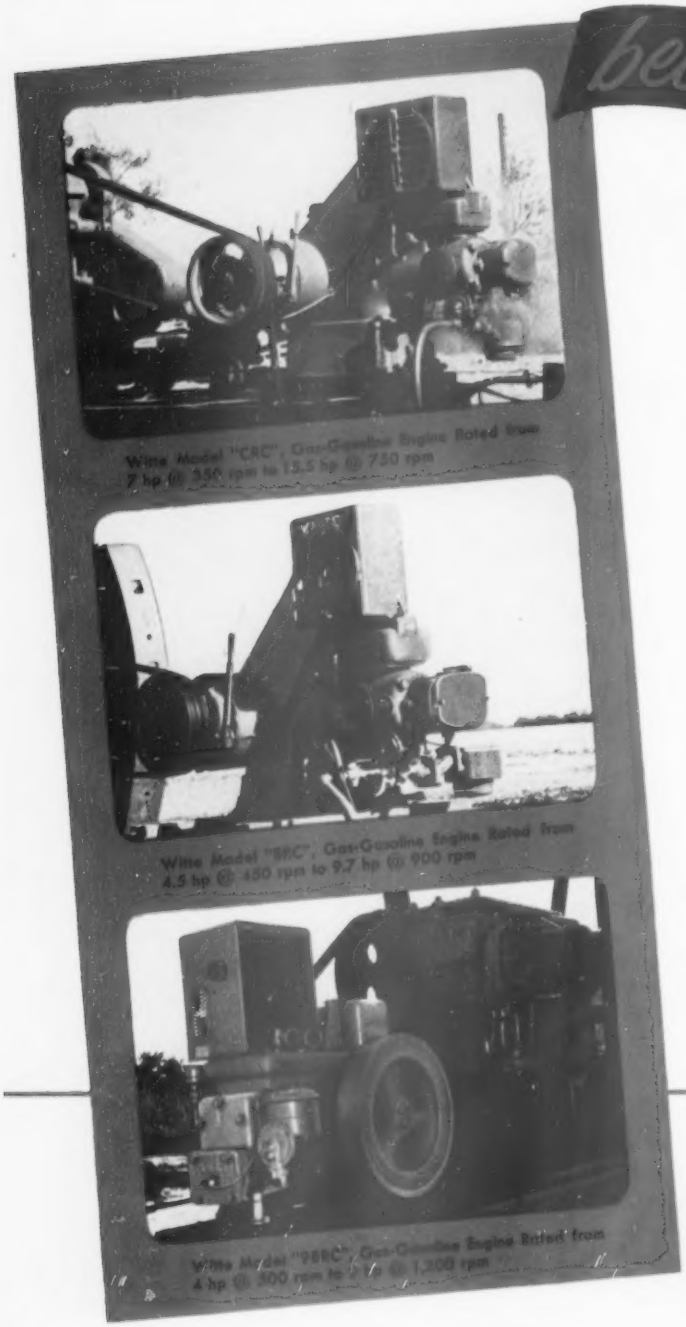
# select a Witte Engine . . .

*because*



**WITTE ENGINES** are of extra strong construction to provide the 24-hour-a-day *dependable operation* necessary to maintain your production schedule.

**WITTE ENGINES** have these *design features* for long operating life: (1) condenser cooling; (2) renewable wet-type cylinder liner; (3) vital engine parts fully protected by dust-proof design; (4) replaceable valve-seat inserts and valve guides; and (5) shim adjustable tapered roller bearings.

**WITTE ENGINES** are available *at your regular supply store*, so you are never far from Witte Sales and Service.

Get all the facts about Witte Oil Field Engines and Engine Generator Units by writing for Booklet W22-54 or ask your nearest supply store.

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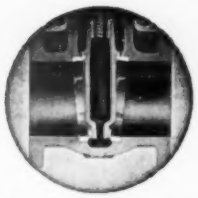
*Gas-Gasoline* models from 4 to 15.5 hp.

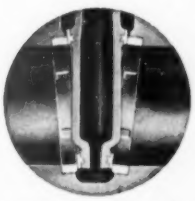
*Full diesel* models from 3.75 to 12.5 hp.

## WITTE ENGINES

UNITED STATES STEEL



**Straight-Flow Port Design** reduces fluid turbulence to a practical minimum.



**Seat Rings** of end-seated type are screwed into the body.

**Sure-Grip Malleable Handwheel** for non-skid gripping even with heavy gloves.

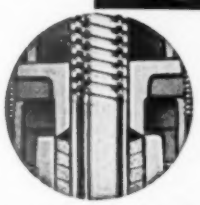
# WALWORTH

# iron body gate valves

**with screwed or flanged ends**

## ... 8 Outstanding Features

For complete information on these new Walworth Iron Body Valves, see your local Walworth distributor, or write for bulletin 106.



**Brass Liner on Glands** assures greater resistance to corrosion and scoring.

# WALWORTH

## valves and fittings

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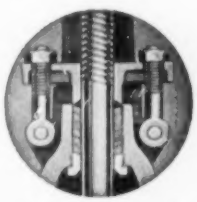
DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

**T-head Disc-to-Stem** connection on OS&Y types provides stronger connection, prevents loosening of disc by corrosion.

**Bronze Back-Seat Bushings** in bonnets of OS&Y valves.

**Solid Web Type Disc** in OS&Y valves for greater strength and longer service.



**Hinged Gland Eye-Bolts** on OS&Y valves permit faster, easier repacking under full pressure.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**For a dependable, unitized drill stem . . .**

# AMERICAN IRON

# *Flash Welded*

## TOOL JOINTS

- Manufactured from forged alloy depth hardening premium steel.
- Threaded prior to heat treatment, assuring maximum strength and durability.
- Every threaded connection is MICROIZED. This acts as lubricant during breaking in periods and retards corrosion of threads.
- Flash welded in the most modern machine available.
- Each joint is checked for alignment with pipe **both** on O.D. and face of joint.
- Available with 18° tapered elevator shoulder or conventional square elevator shoulder.
- Available with hard metal bands on request.*

*American Iron hard metal bands are applied PRIOR to heat treat assuring you a FULLY heat treated tool joint!

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MANUFACTURERS OF A OIL FIELD EQUIPMENT
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PESA

# Keeping Thermal Expansion Under Control

**Flexible support for piping in all positions of travel must be provided, if destructive stresses and strains are to be avoided in today's high temperature piping systems.**

Heat 100 linear feet of alloy steel pipe to 1000° F, and it will expand 9.1 inches! When this thermal expansion takes place in a piping system, the resultant forces induced, if uncontrolled, can do incalculable harm.

**Helical coil springs**

The practice of using helical coil springs to allow this thermal expansion to occur is quite general. But the care that goes into the design or selection of flexible supports ofttimes is haphazard. In fact, many specifications covering the support of important high temperature piping will simply say "spring hangers shall be provided". Merely to contend that this may be dangerous is not enough.

**Safety of entire system at stake**

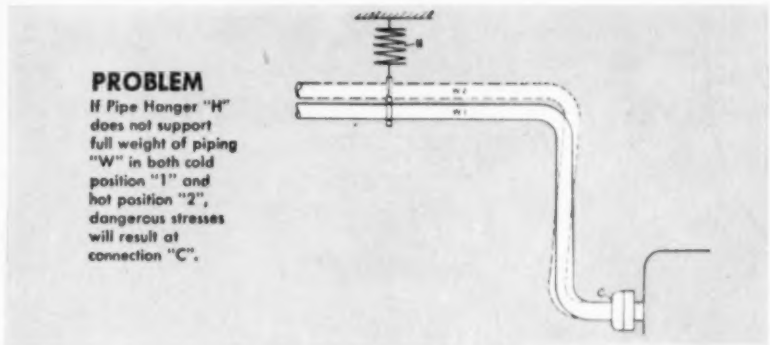
Unless careful study is given to the design and selection of spring supports which will maintain a balanced pipe system, the transfer of weight from one hanger to another, or from a hanger to a terminal point, will endanger the safety factor of the entire system.

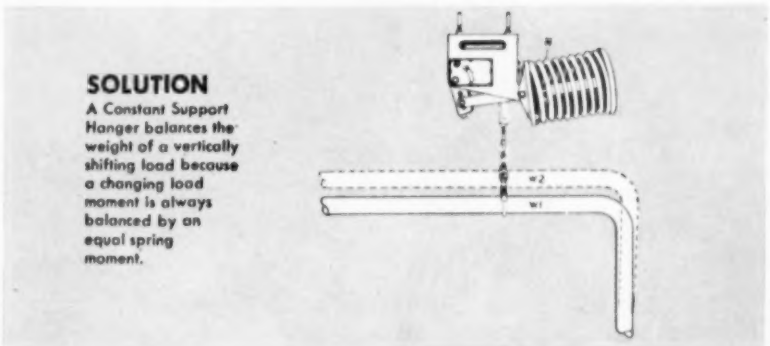
With 8 . . . 9 . . . even 10 inches of thermal deflection not a bit uncommon today, completely flexible support for piping in all positions of travel is a positive "must".

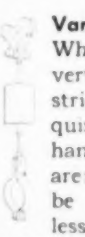
**The case for constant-support hangers**

Where reactive forces at terminal points in a piping system must be kept within specified limits, constant support type hangers are recommended.

They are designed to provide uniform supporting force equal to the pipe load throughout the travel range and should be used at superheater outlets, turbine connections, and also on high temperature and other critical lines.


PROBLEM
If Pipe Hanger "H" does not support full weight of piping "W" in both cold position "1" and hot position "2", dangerous stresses will result at connection "C".

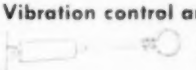

SOLUTION
A Constant Support Hanger balances the weight of a vertically shifting load because a changing load moment is always balanced by an equal spring moment.



**Variable spring hangers**

When pipe lines are subject to vertical movement, and restrictive conditions do not require a constant-support type hanger, variable spring hangers are recommended. They should be designed to support not less than 85%, or more than 120%, of the design load throughout the total travel.

**Vibration control and sway brace**



When necessary to prevent abnormal movement or vibration in pipe lines, controls or sway braces of the energy-absorbing or instant-acting counter force type, are recommended. They dampen vibration, oppose pipe sway and absorb shock.

**Hanger Engineering Service**

The Pipe Suspension Department of Grinnell Company offers a design service to engineering firms which appreciate the specialized knowledge required to compute hanger loads and to select the proper supports for a balanced pipe suspension system when high pressures and high temperatures are involved.

Grinnell manufactures a complete line of pipe hangers and supports; maintains an experienced laboratory staff of technicians to discover better ways of solving pipe suspension problems; provides engineering assistance in design and installation; offers stocks of pipe hangers close to any job.

**Hanger load calculation booklet**

A 28-page booklet entitled "Hanger Load Calculations", compiled to furnish necessary data and procedure to determine pipe hanger loads, can be obtained from Grinnell Company. The tabulations of piping weights and thermal expansion have been arranged for convenient selection of data that otherwise consume considerable time to develop. It's yours without obligation.

GRINNELL COMPANY, INC.

256 West Exchange St., Providence, Rhode Island

Kindly send me a complimentary copy of your "Hanger Load Calculations" booklet.

Name .....

Company .....

Address .....

City ..... State .....

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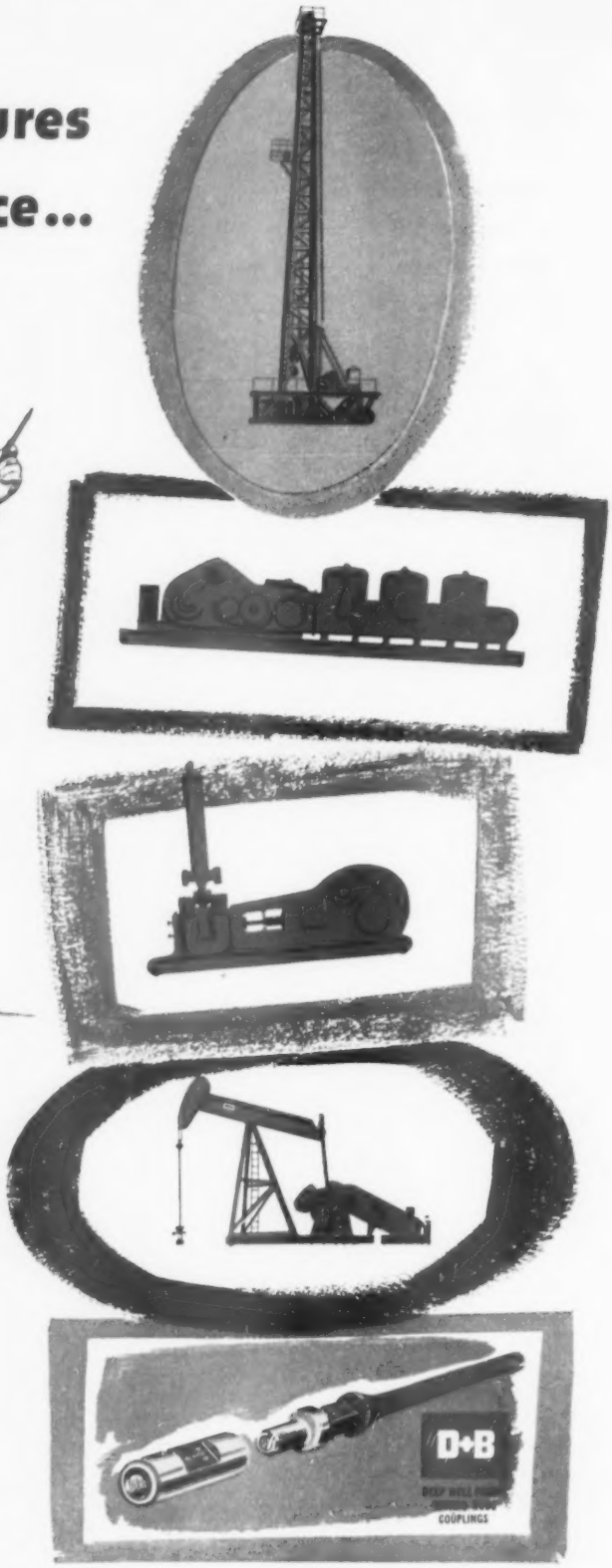


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# What chance do your valves have in a fire?

Not much if your valves depend on "O" rings, rubber or synthetics for a seal. What's worse, a leaking valve can keep pouring fuel into the fire. But a W-K-M Valve, with its metal-to-metal seal on all sides, has the greatest chance of survival through the worst of fires. And it will hold tight to prevent further damage under conditions short of total destruction.

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**W-K-M COMPANY**

**W-K-M Valves**

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Spicer has *always looked ahead* . . . continually developing universal joint refinements that have anticipated new needs in automotive service.

Spicer *is ahead today* . . . with outstanding design features in its flange- and yoke-type line of universal joints . . . with a greater number of units in service than any other make . . . and with an unequaled performance record of nearly a half-century in all types of vehicles on all types of duty.

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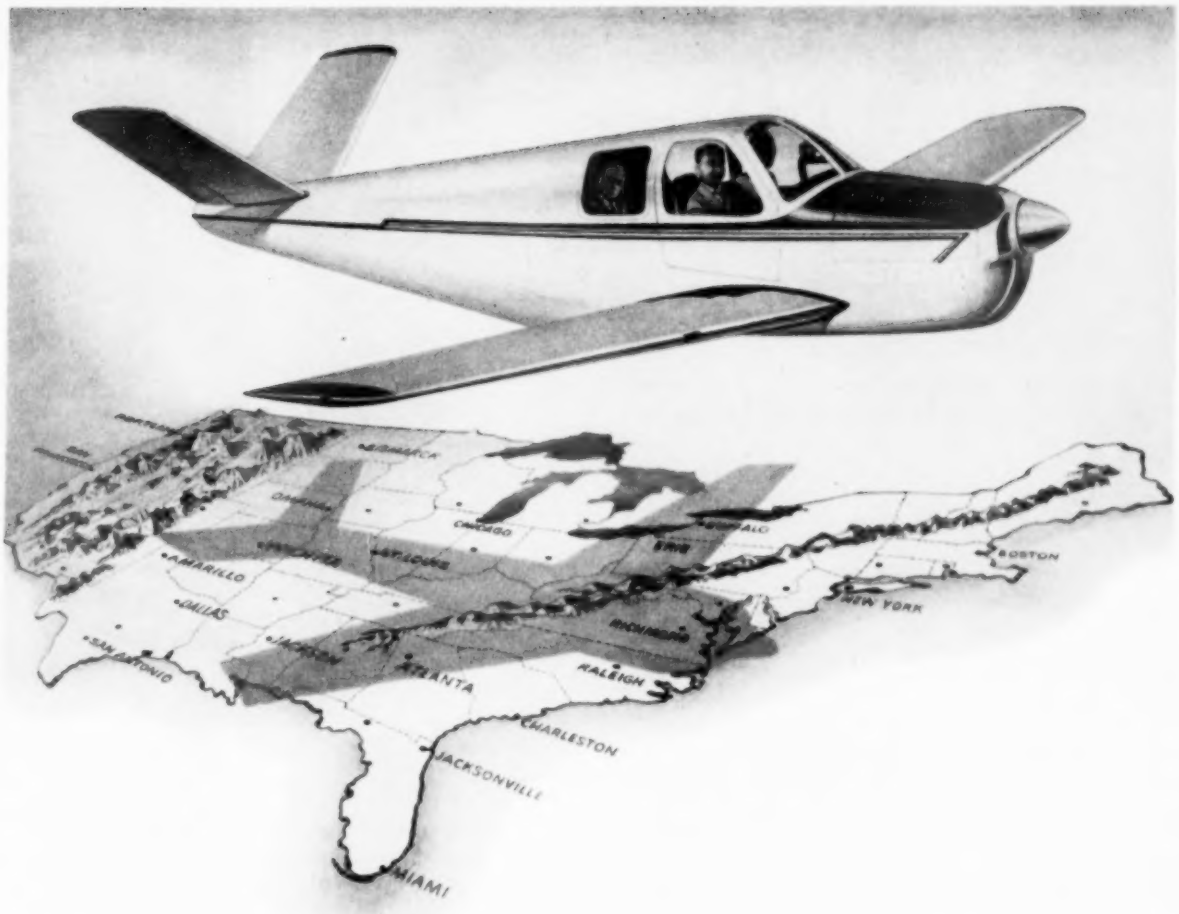
POWER TAKE-OFF JOINTS • RAIL CAR DRIVES • RAILWAY GENERATOR DRIVES • AIRCRAFT GEARS • WELDED TUBING

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The right man – with the right answer, at the right place, at the right time – lands the contract. Beechcrafts enable busy executives to cover every base of activity – and still handle necessary office routine, with more time at home, too.

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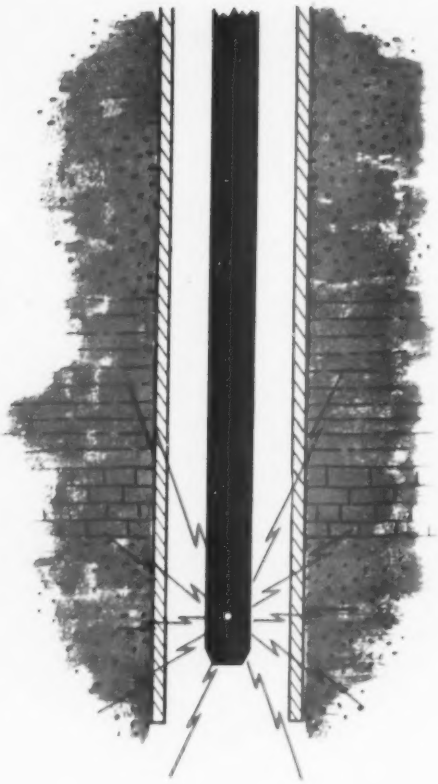
# RADIOACTIVITY LOGGING

now offered by **HALLIBURTON**



**Makes a 12th HOWCO Service For Obtaining Petrophysical Data**

Most advanced techniques in Radioactive Logging now bring you new benefits with Halliburton's comprehensive Electrical Well Service. The tool obtains reliable stratigraphic information and fluid content through casing or in open hole with accuracy unaffected by well fluids.

Halliburton's method employs a unique Geiger-type counter for detection of gamma rays that is considerably more efficient than the usual Geiger counter because of its special construction. More stable instruments can be built to measure counts than to measure the direct current output of other Radioactive methods.

Pertinent characteristics of this logging method are:

- **Simultaneous recording of natural gamma and induced gamma radiation, together with an electronic collar locator.**
- **Radiation curves accurately recorded in absolute counts.**
- **Counts are measured from a precise zero.**
- **Log automatically recorded on film.**

Hydrogen content or porosity is measured by induced gamma radiation from neutron bombardment. In this manner the record is influenced less by hole diameter and influenced more by material at greater distance from the bore hole.

Additional features of Halliburton's Radioactive Logging include...special design in shielding arrangement using tungsten and lead which is least affected by scattered gamma radiation from radium sources; electronic collar logging that is more accurate in determining precise depths of formations; availability of complete logging services with the same basic equipment; superiority of film recording.

The great and growing demand for well logging is met and exceeded by Halliburton's research and progress in Electrical Well Services. With 12 analytical tools for obtaining precise measurements of petrophysical data, and highly skilled specialists to correlate and interpret all information, you can rely more than ever on Halliburton's complete logging service.

Phone your local or district Halliburton office. Or contact Halliburton Oil Well Cementing Company, Duncan, Oklahoma.

HALLIBURTON

ELECTRICAL WELL SERVICES

PERPETUAL PROGRESS IN PRODUCTION IMPROVEMENT TECHNIQUES

# LEASE OPERATORS!

## Here's The New BS&B ECON-O-MAX* LTS UNIT

*Especially Designed for*

## SMALL CAPACITY–HIGH PRESSURE GAS WELLS!

The new BS&B ECON-O-MAX* LTS Unit is a practical and economical means of putting low temperature separation to work on small gas-distillate wells having flowing pressures of 1000 to 1800 psi, and capacities of only ½ to 3 MMSCFD!

The ECON-O-MAX* Unit is the result of efforts by BS&B field men and engineers to perfect a new, simple, low-cost LTS unit for use on wells with small volume production where the investment required for a larger COLD-FRAC* Unit was not economically justifiable. It consists basically of a vertical low temperature separator with coil, piping and choke—the *heart* of the COLD-FRAC* System. Indirect heater and low pressure separator may be added, where necessary.

Although comparable in cost with a conventional stage separation unit, extensive field testing by lease operators has proved that the ECON-O-MAX* Unit will recover up to 50% more condensate!

If you have been limited by small production to using conventional stage separation on your lease, we'd suggest you let your BS&B Representative give you the facts about this newest member of the COLD-FRAC* line — the ECON-O-MAX* LTS Unit! Or if you prefer, we'll be glad to send you complete information.

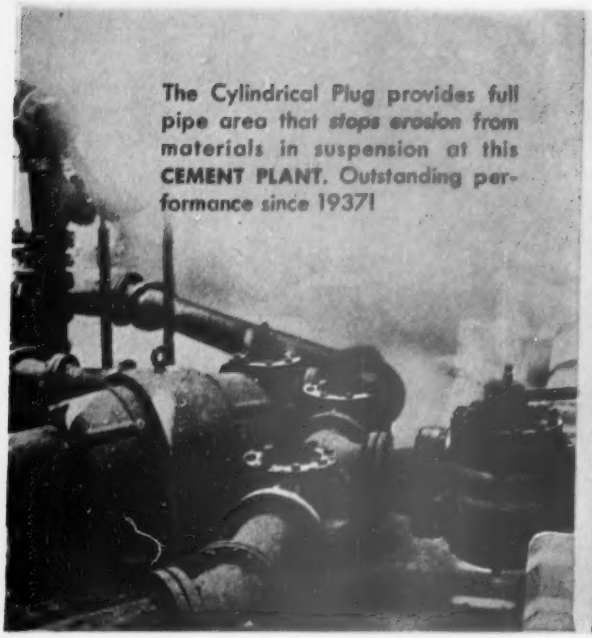
*"ECON-O-MAX" and "COLD-FRAC" are trade-marks of Black, Sivalls & Bryson, Inc.

EFFICIENCY OVER 60 YEARS BS&B RELIABILITY

**BLACK, SIVALLS & BRYSON, INC.**

Oil & Gas Equipment Division, Dept. 1-A4A

1708 West Main Street — Oklahoma City, Oklahoma



The Cylindrical Plug provides full pipe area that *stops erosion* from materials in suspension at this **CEMENT PLANT.** Outstanding performance since 1937!

In **SEWAGE PLANTS,** a.c.f. Cylindrical Plug shears obstructions on raw sewage and sludge lines or, as here, controls gas for heat booster on digestor circulating water.

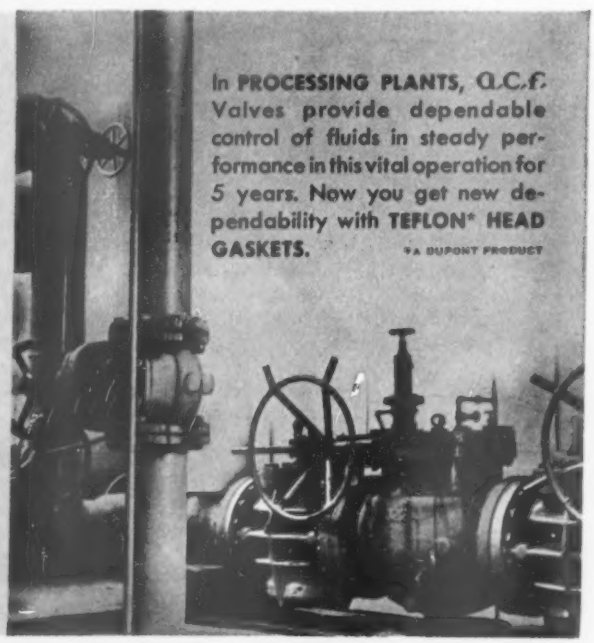
# PROOF OF SUPERIORITY

## a.c.f. CYLINDRICAL FULL PIPE AREA PLUG VALVES

Representatives in 50 Principal Cities

Write for descriptive Catalog 4.0G to American Car and Foundry Company, Valve Division, 1501 E. Ferry Avenue, Detroit 11, Michigan.

***Quick, quarter-turn shut-off*** provides positive, immediate control vital to this **NATURAL GAS OPERATION.** Straight-through streamline flow in a.c.f. Valves assures least turbulence and pressure drop at all times.



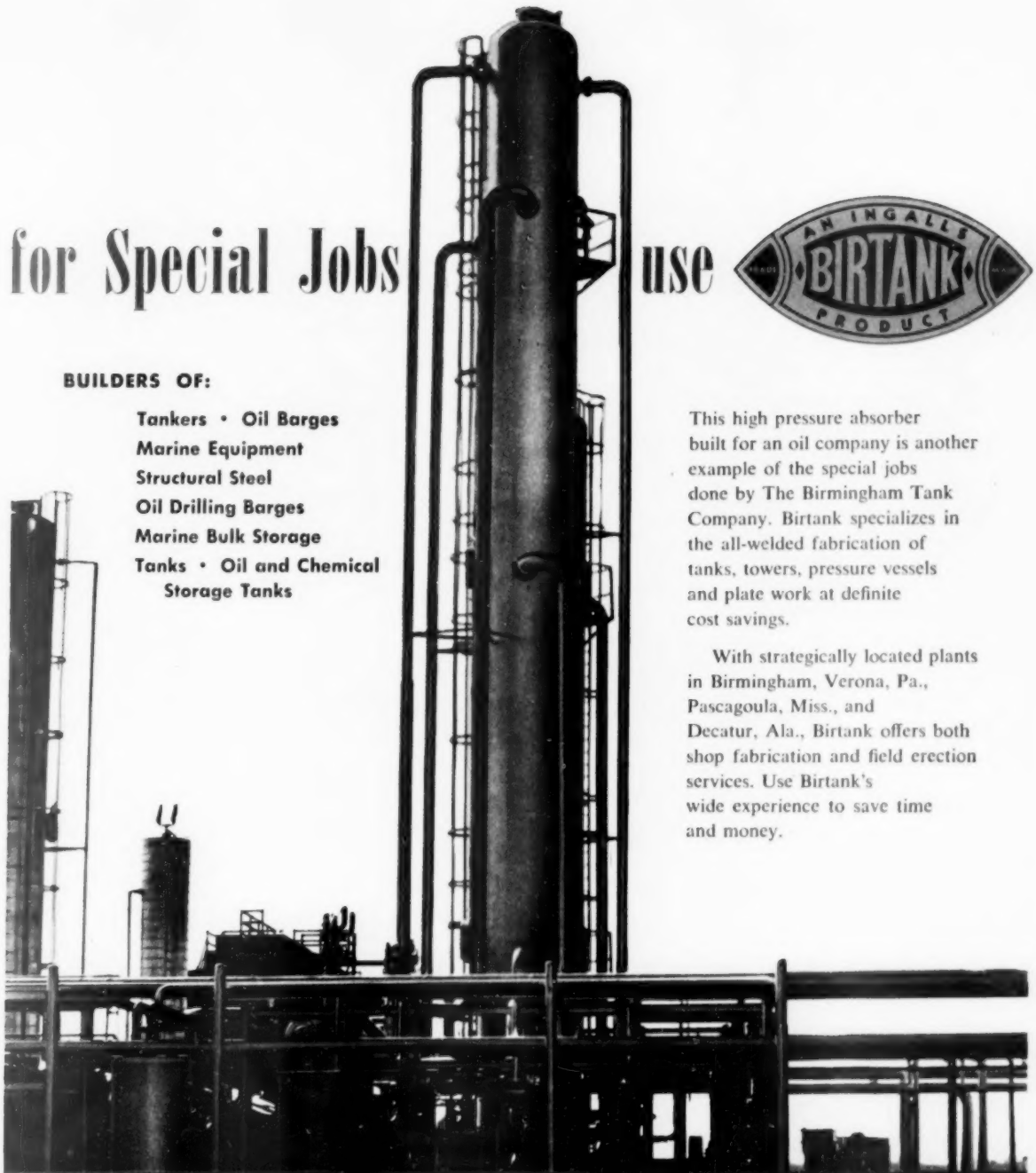
In **PROCESSING PLANTS,** a.c.f. Valves provide dependable control of fluids in steady performance in this vital operation for 5 years. Now you get new dependability with **TEFLON* HEAD GASKETS.**

*A DUPONT PRODUCT

# for Special Jobs use AN INGALLS BIRTANK PRODUCT

**BUILDERS OF:**

**Tankers • Oil Barges**
**Marine Equipment**
**Structural Steel**
**Oil Drilling Barges**
**Marine Bulk Storage**
**Tanks • Oil and Chemical Storage Tanks**



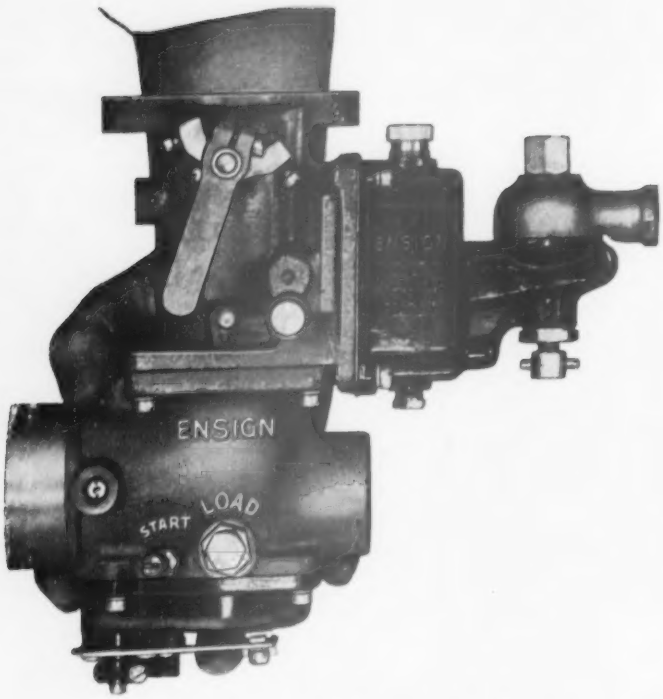
This high pressure absorber built for an oil company is another example of the special jobs done by The Birmingham Tank Company. Birtank specializes in the all-welded fabrication of tanks, towers, pressure vessels and plate work at definite cost savings.

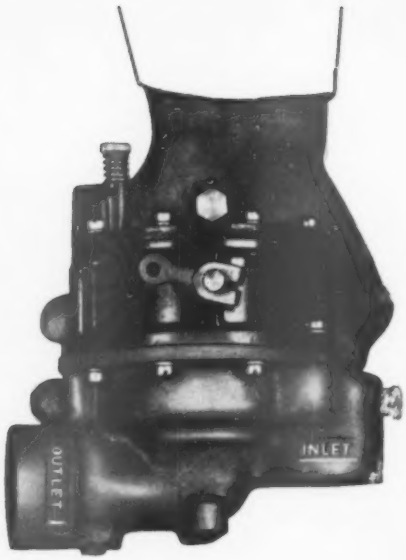
With strategically located plants in Birmingham, Verona, Pa., Pascagoula, Miss., and Decatur, Ala., Birtank offers both shop fabrication and field erection services. Use Birtank's wide experience to save time and money.

**TANKS**
**A type and size for every oil storage requirement**

FOR COMPLETE INFORMATION ON BIRTANK WRITE:

**BIRMINGHAM TANK COMPANY**




# ENSIGN

Ensign is an old familiar name in the oil industry. For many years it has been a symbol of DEPENDABILITY. A gas engine powered drilling rig or pumping unit, when equipped with Ensign carburetion, is under all operating conditions most likely to give the best service. This is because of our unending search for improvements in the carburetor art plus the fact that all improvements are subjected to rigorous laboratory and field tests before they can carry the name ENSIGN.

The carburetor above, Model Kgnl, is a combination gasoline-natural gas and propane unit. The Model B fuel regulator is designed for natural gas or propane. When propane is used, the vaporizer shown below is also employed. Ensign catalogs completely describe the hook-up, which is fast and easy to make.

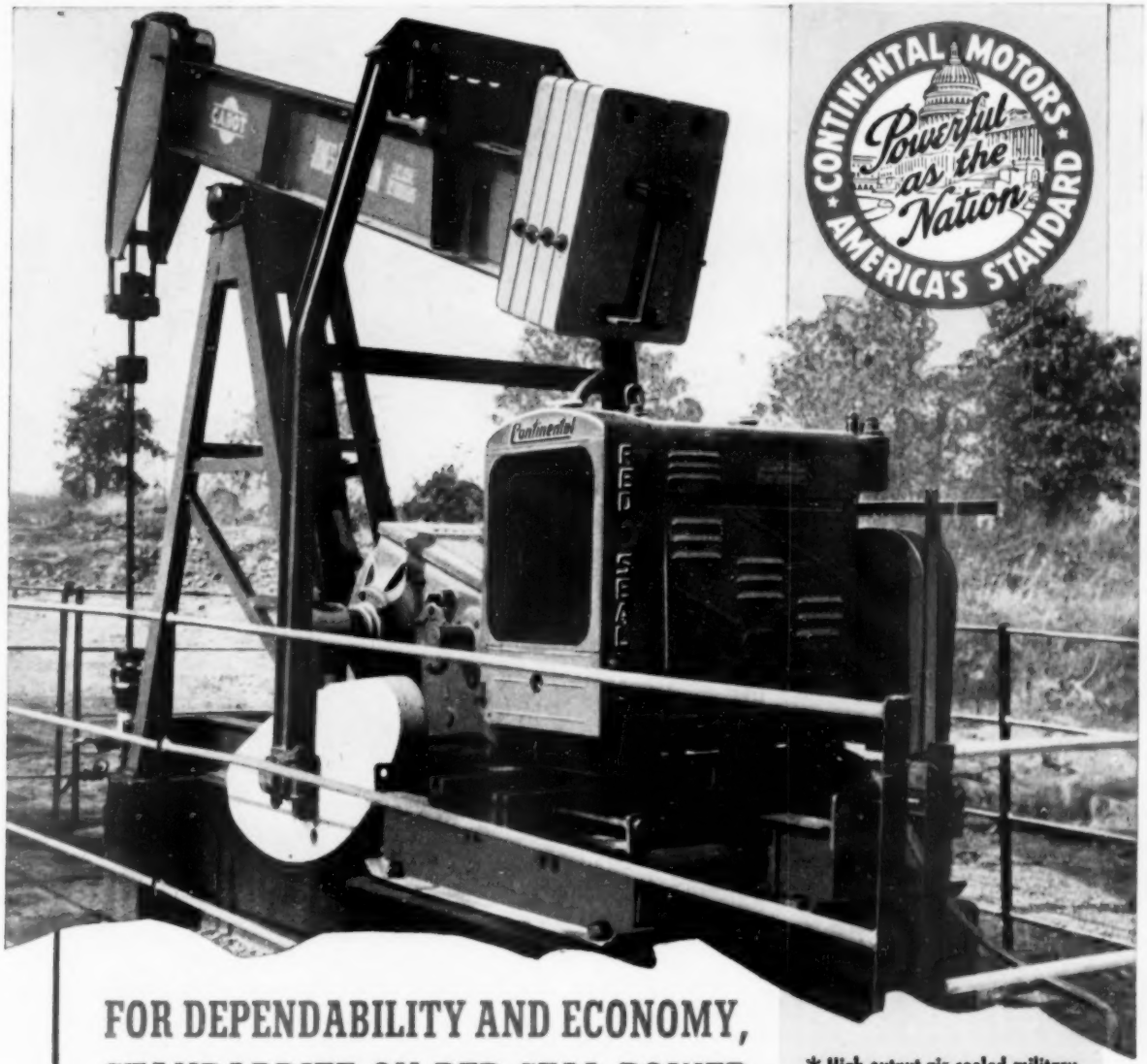
**ENSIGN LP-GAS (Propane) VAPORIZER**

Converts liquid fuel to dry gaseous vapor prior to entering the Model B fuel regulator and carburetor.

**ENSIGN CARBURETOR COMPANY**

7010 So. Alameda St. Huntington Park, Calif.

2330 West 58th St. Chicago 36, Ill.




# FOR DEPENDABILITY AND ECONOMY, STANDARDIZE ON RED SEAL POWER

The petroleum industry's widening use of Red Seal engines traces mainly to two factors. One is the broad diversification of the Red Seal line—more than 100 basic models, from 10 h.p. to 1,000-plus*, for use on all standard fuels. The other is Continental's long standing reputation for *dependability*—their inbuilt capacity to *deliver more power, longer, at lower cost.* Ask for them at your supply store.

PARTS AND SERVICE EVERYWHERE

*** High-output air-cooled military models developed jointly by Army Ordnance and Continental are now available for commercial applications where high output (375 to 1,000-plus h.p.) low weight, and exceptional compactness are required. For information, address Continental Motors Corporation, Military Division, 76 North Getty Street, Muskegon, Michigan.**

•

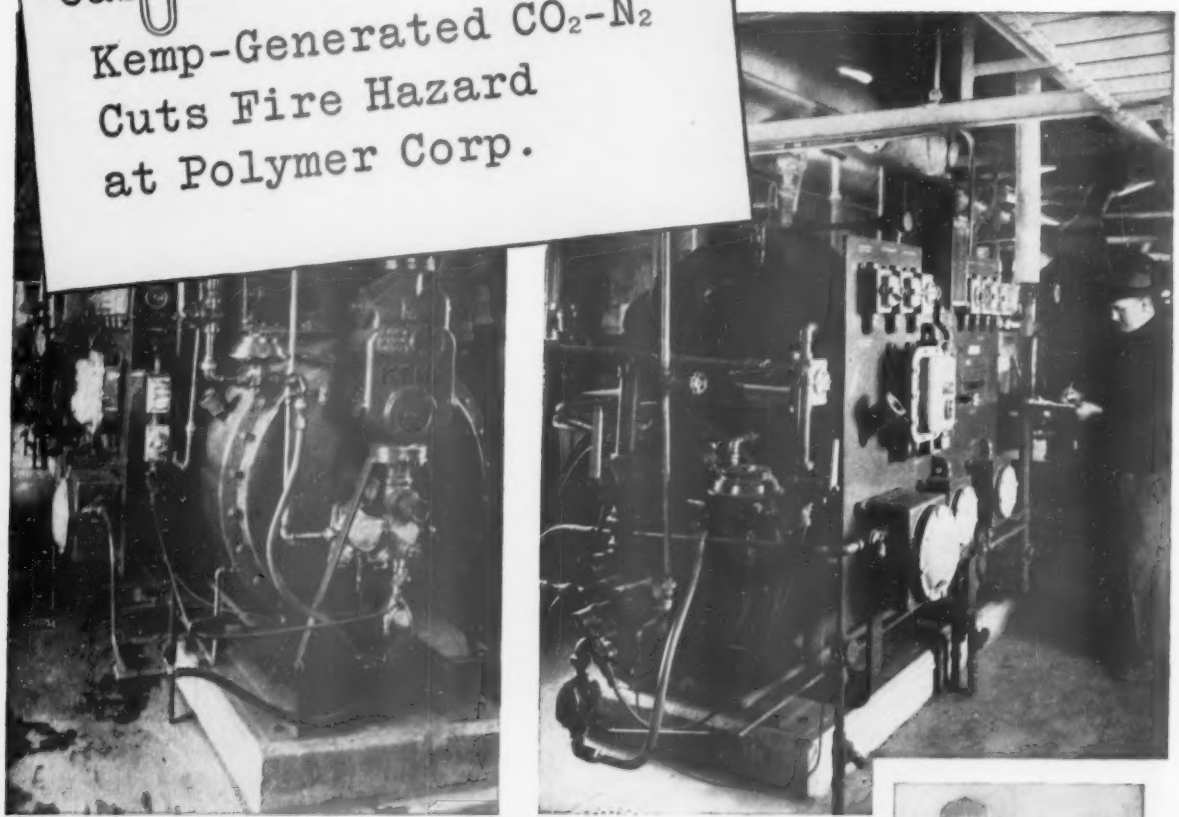
1819 BROADWAY, NEW YORK 23, NEW YORK • 1252 OAKLEIGH DRIVE, EAST POINT (ATLANTA) GA. • 6218 CEDAR SPRINGS ROAD, DALLAS 9, TEXAS • 3817 S. SANTA FE AVE., LOS ANGELES 58, CALIF. • 910 S. BOSTON ST., ROOM 1008, TULSA, OKLA.

**Continental Motors Corporation**

MUSKEGON, MICHIGAN

Case No. 62

Kemp-Generated $CO_2$-$N_2$ Cuts Fire Hazard at Polymer Corp.



# How Polymer operated day and night for 10 years at maximum safety

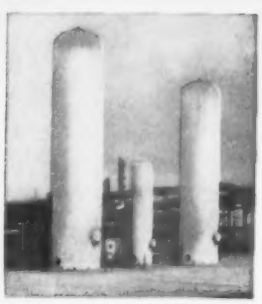
When Polymer Corporation, Ltd., Sarnia, Ontario, began operations in 1943, inventory included two Kemp MIHE Inert Gas Generators. Since that date, Polymer—and its Kemp equipment—has been operating 24 hours a day, 365 days a year. The huge quantities of man-made rubber and associated chemicals it produces—200,000,000 pounds during one year alone—reach, in one form or another, the four corners of the world.

### Kemp Plays an Important Role

The high volatility of many of the ingredients used in this giant operation necessitates blanketing and purging vessels after use. It is in this step that Polymer employs Kemp Generators to assure safe, trouble-free performance. The gas they produce is piped to different operations over the entire company area—it *must* be clean! Kemp does the job—Polymer knows that it can depend on Kemp to deliver a *clean inert at a specific analysis, regardless of demand*. And every Kemp Generator is engineered for fast starts and easy operations that save *time* and *money*.

### Kemp Can Do a Job for You

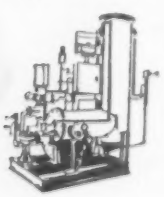
Kemp superiority is no accident. It is based on years of experience . . . on quality of design to meet specific problems. Every Kemp design features the Kemp Industrial Carburetor for complete combustion without tinkering or waste . . . for simplified installation and maintenance. Every Kemp design includes the latest fire checks and safety devices. If you have a blanketing or purging problem, contact Kemp engineers. They will be glad to study your situation and recommend the installation best suited to your needs. No obligation, of course.



**Gas generator building from which inert gas is piped over 130 acres of company property at Polymer's Sarnia, Ontario, operation.**

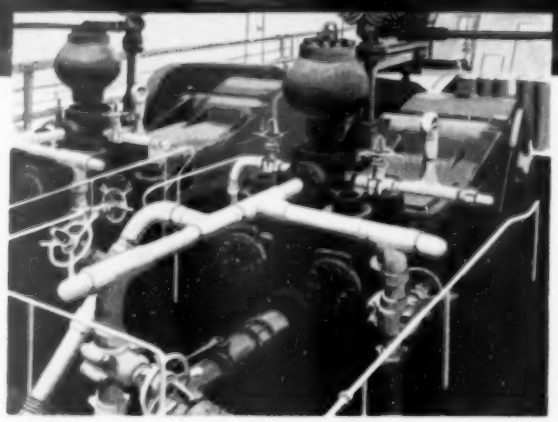
*For more complete facts and technical information, write for Bulletin I-10 to:* **THE C. M. KEMP MFG. CO., 405 East Oliver Street, Baltimore 2, Md.**

**KEMP OF BALTIMORE**



**INERT GAS GENERATORS**

CARBURETORS • BURNERS • FIRE CHECKS
METAL MELTING UNITS • ADSORPTIVE DRYERS
SINGEING EQUIPMENT



This is the type of installation in which Gardner-Denver Mud Pumps are most appreciated

**THE CONTINENTAL SUPPLY COMPANY**
General Offices: DALLAS, TEXAS
*Representatives in All Principal Oil Fields of the World*

**CONTINENTAL**
*Serving the Oil and Gas Industries*

# Drilling tenders demand the best

Gardner-Denver Mud Pumps are designed to operate at the extreme loads and pressures of today's toughest drilling conditions.

Gardner-Denver Mud Pumps deliver this important service with a minimum amount of down-time because:

They are designed for maximum accessibility in the restricted area encountered in a tender installation and . . .

Without exception, all parts (including every bearing) can be replaced without removing the pump.

# A ROPE

## IS NOT JUST A ROPE

...WHEN THERE ARE 112 YEARS EXPERIENCE BEHIND IT. NEW BEDFORD IS THE MOST RESPECTED NAME IN CORDAGE. DRILLING CREWS TODAY, EVERYWHERE, KNOW THE FEEL OF THIS MAGNIFICENT ROPE.

**CONTINENTAL**

*Serving the Oil and Gas Industries*

**THE CONTINENTAL SUPPLY COMPANY**

**General Offices: DALLAS, TEXAS**

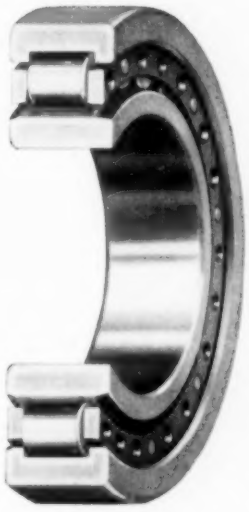
*Representatives in All Principal Oil Fields of the World*

**WHATEVER YOUR ROLLER BEARING APPLICATION**

# specify BOWER!

Earthmovers, jet turbine engines, rolling mill equipment, truck axles—you name it! Bower builds a complete line of tapered, straight and journal roller bearings including a size and type to fit *your* product. What's more, these dependable bearings have *proved* themselves in virtually every conceivable type of application. Their built-in quality, skillful engineering and advanced design features provide such important bearing advantages as reduced wear, longer life and lower maintenance requirements. Let a Bower engineer give you full details on the complete Bower line.

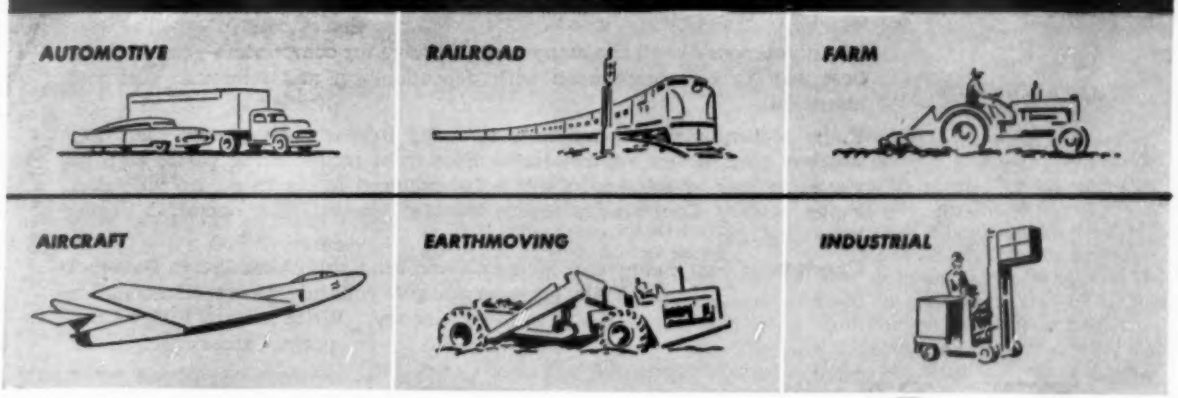
BOWER ROLLER BEARING COMPANY
DETROIT 14, MICHIGAN



***BOWER TAPERED ROLLER BEARINGS INCORPORATE ADVANCED SPHER-O-HONED DESIGN!*** Spherically generated roll heads and higher flange with larger, two-zone contact area reduce wear, improve roller alignment and virtually eliminate "end play." This helps hold adjustment and pre-load longer and better. Larger oil groove provides positive lubrication.

***BOWER STRAIGHT ROLLER BEARINGS ARE BUILT TO CARRY MAXIMUM LOADS!*** Integral two-lip race increases rigidity—keeps rollers in proper alignment at all times. Steel cage allows free movement of rollers between races during normal operation. High-grade alloy-steel rollers and races are precision-ground for quieter, smoother operation.

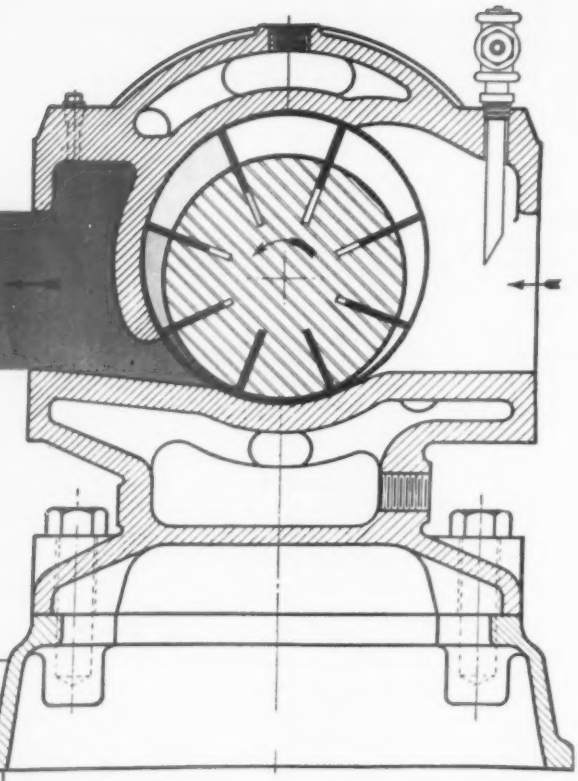
**A COMPLETE LINE OF TAPERED, STRAIGHT AND JOURNAL ROLLER BEARINGS**
*for every field of transportation and industry*




BOWER
ROLLER BEARINGS

SPHER○HONED

# putting the SQUEEZE on compression costs



Check your needs for • • • • *Gas Gathering* • *Gas Boosting*
*Repressuring Flare Gas*
*Refrigerant Compression* • *Engine Starting Air* • *Pneumatic Power*
*Pneumatic Controls* • *General Plant Air*

When you consider all the many uses you have for compressors—consider the best way to get compression with dependability, and minimum cost and attention.

Fuller Rotary Compressors have so many inherent advantages that they warrant your closest examination. Free from reciprocating parts, with no valves to leak or seats to grind, no unbalanced forces to set up vibration. Fuller Rotary Compressors assure low-cost, smooth-flow operation during their long life.

Check your own compressed-air needs and send this check list to Fuller. A Fuller engineer will give you the *right* recommendation to save you money. Write now to Fuller Company, Catasauqua, Penna.

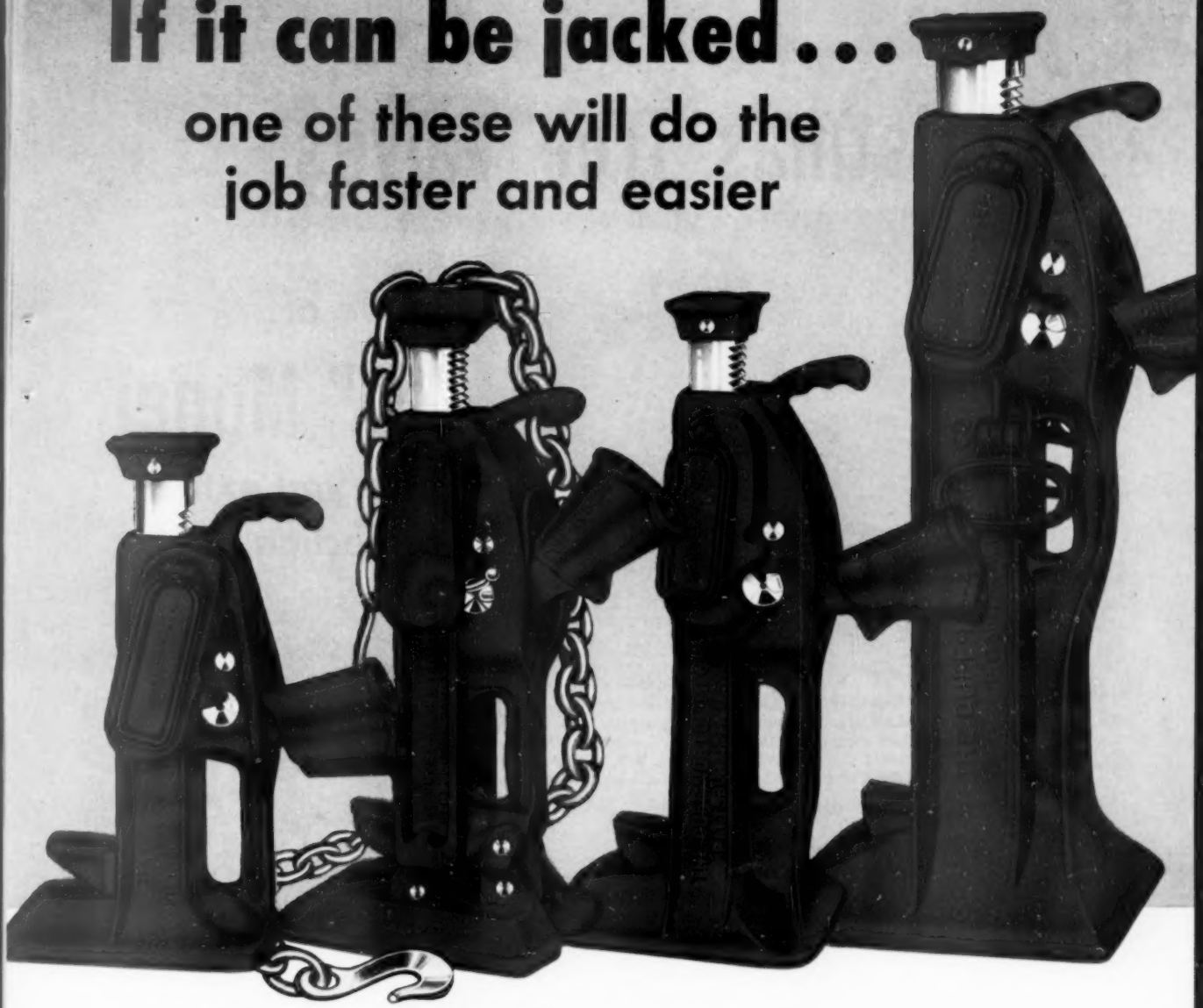
**Fuller** Pioneers of high-efficiency vane-type rotary compressors

**FULLER COMPANY**
**Catasauqua, Pa.**
*Branch Offices: Chicago • San Francisco • Los Angeles • Seattle • Birmingham*

C-231
1950

# If it can be jacked...

## one of these will do the job faster and easier



"The Roustabout"

| No. 516-MT | No. 1523 | No. 1022 | No. 2028 |
|---|---|---|---|
| 5-TON CAPACITY | 15-TON CAPACITY | 10-TON CAPACITY | 20-TON CAPACITY |

**For Better Service**—Duff-Norton maintains complete stocks of jacks of all kinds—ratchet, screw and hydraulic—in *the only jack warehouse in the oil country* at 209 West First Street, Odessa, Texas. Phone 6-3021.

The job will always go faster and easier when you use the correct jack for the job at hand. These rugged, dependable, powerful Duff-Norton jacks are designed and built for years of trouble-free service.

All contain the exclusive, patented, Duff-Norton spring mechanism that assures safe, positive action in lifting or lowering. All have sturdy foot lifts for getting a toe-hold under low set loads.

All are available from your favorite supply store. For complete information on these and many other Duff-Norton Jacks, write the world's oldest and largest manufacturer of lifting jacks for special Oil Field Jack Bulletin, AD 19-B, the Duff-Norton Manufacturing Co., P. O. Box 1889, Pittsburgh 30, Pa. Canadian plant—Toronto 6, Ont.

# DUFF-NORTON *Jacks*

*"Givina Industry a Lift Since 1883"*

Now...

# Christmas Tree Valves

made of

## "K" Monel

give you extra protection

For extraordinary strength in the presence of high pressure well fluids saturated with corrosive gases, this valve was made with a forged "K" Monel body and bonnet. Seat is Monel. This 2-in. Series 1500 A.P.I., 5,000 lbs. W.P. (10,000 lbs. test) valve was fabricated by Cameron Iron Works Inc., Houston, Texas.

The rough forging of the first "K" Monel Christmas tree master valve body.

The first Christmas tree master valves ever made with forged "K" Monel bodies are now available from Cameron Iron Works Inc.

They were designed as a result of the increasing need for master valves made of an alloy that would successfully resist high well pressures in the presence of well fluids saturated with hydrogen sulfide.

Exhaustive tests made in the laboratory and confirmed in the field indicate that "K" Monel is not subject to stress-corrosion cracking in an environment of hydrogen sulfide and water.

The valve body and bonnet were forged from a special forging grade of "K" Monel. Every unit of the Christmas tree manifold is produced in the Cameron plant to insure the proper functioning of each component part.

This represents only the latest application of "K" Monel with its useful combination of high corrosion resistance, high strength and hardness. It has long been used for such equipment as drill collars, sucker rods, valve stems, gas lift valve parts, bottom hole pumps and instruments.

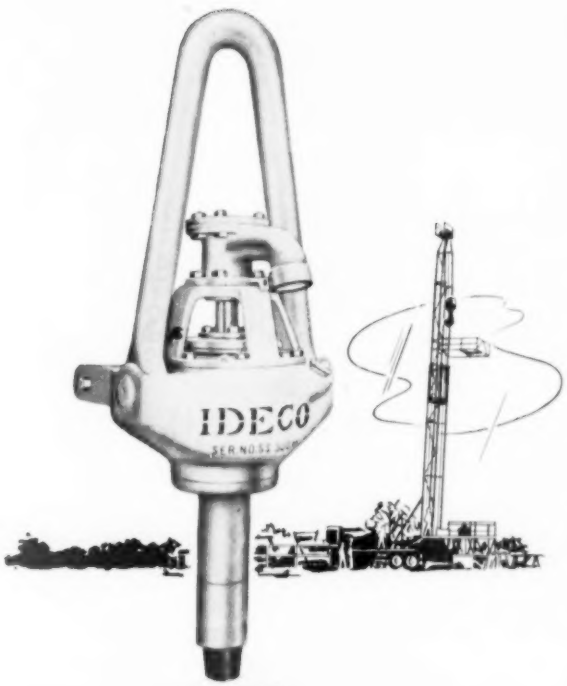
For full information on high strength "K" Monel for Christmas tree valves write to C. J. Brown of our Inco Nickel Alloys Department.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

## Inco Nickel Alloys

MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL
"S"® MONEL • INCONEL® • INCONEL "X"® • INCONEL "W"® • INCOLOY®
NIMONIC® Alloys • NICKEL • LOW CARBON NICKEL • DURANICKEL®

# WHY J&L RECOMMENDS ideco SWIVELS




IDECO swivels have a floating, self-centering wash pipe.

**Contractors tell us they commonly drill four or five wells, with pressures from one thousand to two thousand pounds, before replacing washpipe or packing in an IDECO.**

When finally needed, the special packing cartridge can be installed by one man in a few minutes—usually with no more than 20 to 25 minutes of downtime.

These IDECO Streamlined Swivels are made in four sizes for light, medium, and heavy drilling.

You can have them with either tapered or straight roller main bearings—the assemblies are interchangeable.

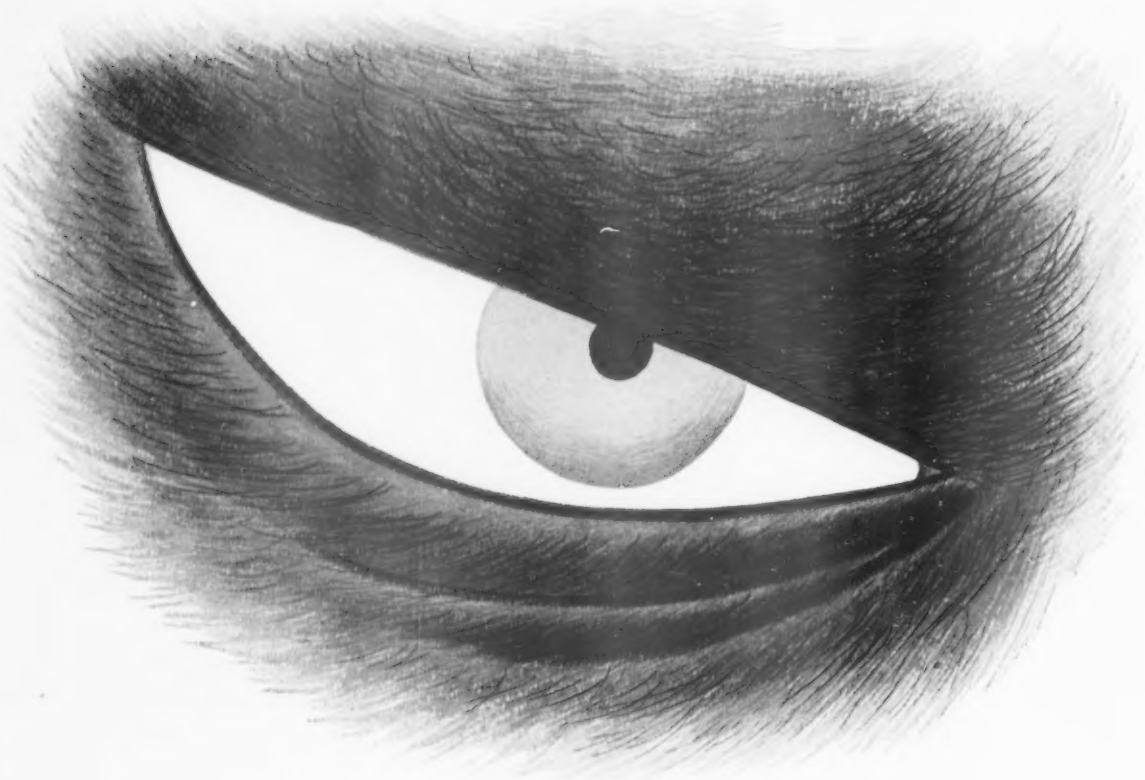
All J&L men can supply an IDECO bulletin on these remarkable streamlined swivels. Ask for your copy.

J&L STEEL

**JONES & LAUGHLIN STEEL CORPORATION**
**SUPPLY DIVISION**

*Serving The United States and Canada*
General Offices: Tulsa, Oklahoma
J&L Tubular Products and Wire Rope

PESA
PARTNERS IN PETROLEUM PROGRESS



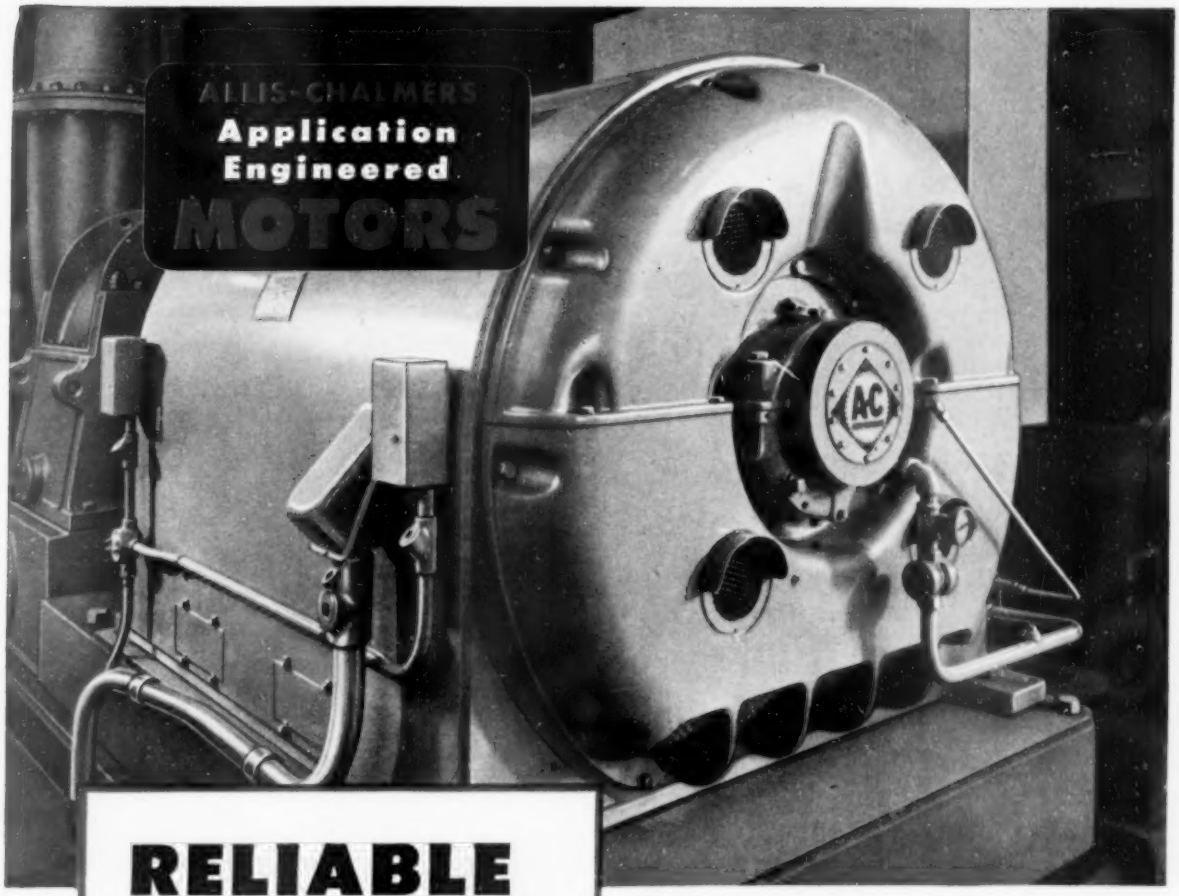
Like an evil eye, fire is constantly on the lookout for unprotected hazards such as flammable liquids, electrical equipment, materials in process. Get protection that never sleeps. Guard every hazard in your plant with a Kidde Automatic Fire Extinguishing System.

Quick as a wink, check the 'yellow pages' for your local Kidde dealer.

The words 'Kidde', 'Fyre-Freez' and the Kidde seal are trademarks of Walter Kidde & Company, Inc.

Kidde

Walter Kidde & Company, Inc.
454 Main St., Belleville 9, N.J.
Walter Kidde & Company of Canada, Ltd., Montreal—Toronto




# RELIABLE LOW-COST Air *for Fluid Catalytic Cracking Units*

Frontier Oil Refining Company uses a 3000-hp, 4160-volt, 1790-rpm Allis-Chalmers cage motor to drive an Allis-Chalmers 4-stage centrifugal main air blower at its Buffalo, New York, refinery.

**Motor-driven** installations have proved that modern electric power systems can provide the service reliability required for catalytic cracking blower and compressor drives. And they can do the job cheaper than steam turbine drives in most cases.

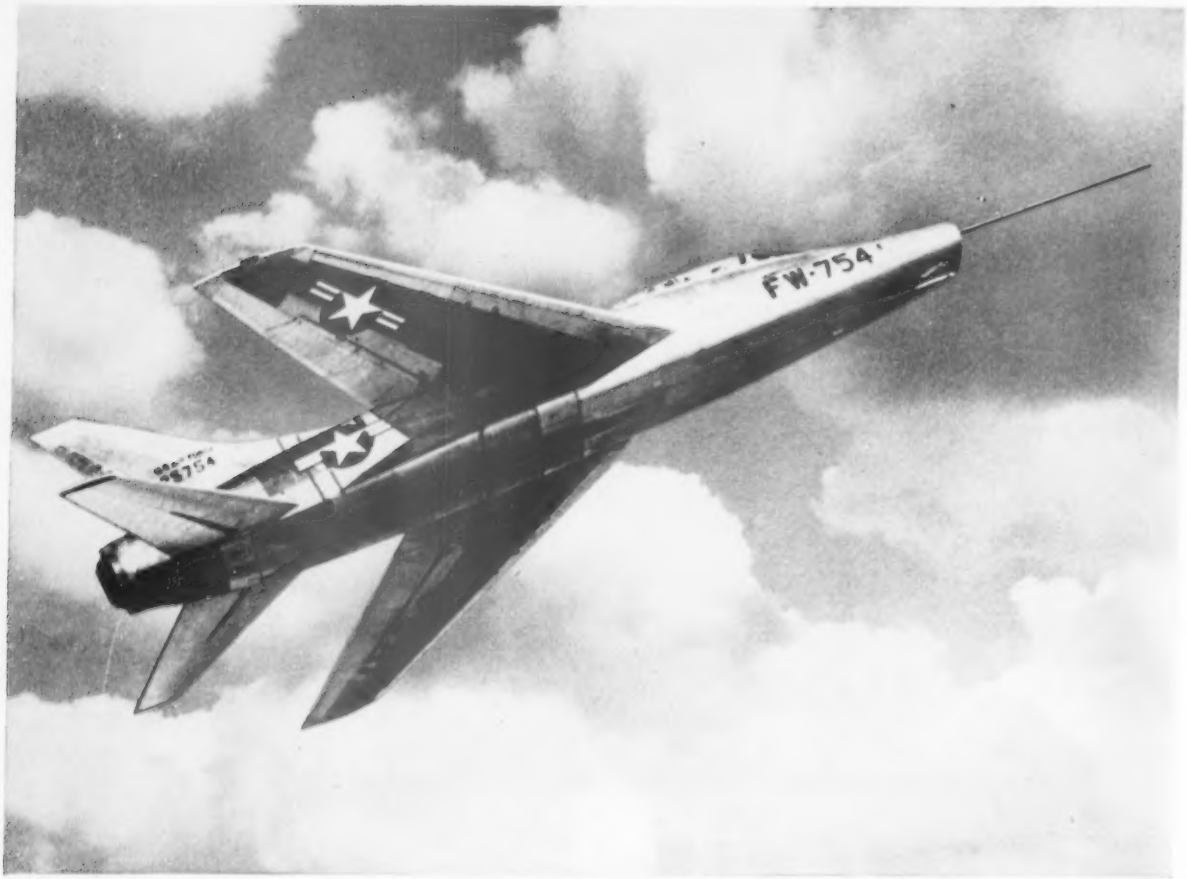
Initial investment savings of $500,000 have been reported. Maintenance costs are significantly lower. Relative operating costs, while determined by prevailing power rates and other factors, are often lower for electric drive installations.

Allis-Chalmers can supply synchronous or induction motors engineered to meet any FCCU requirements. Both types are available in drip-proof, splash-proof, pipe or forced-ventilated, totally-enclosed fan-cooled, and explosion-proof designs. All are built for maximum dependability plus ready accessibility for inspection and maintenance.

Your nearby A-C representative can help you determine the relative merits of steam and electric drives for specific applications. Allis-Chalmers, Milwaukee 1, Wis.

A-4295

**ALLIS-CHALMERS**




**JET PLANES** like this F-100 may be made more effective by Standard Oil's development of a new grease, using aryl-substituted ureas, that outperforms any previous one in certain high temperature bearings of aircraft.

# HOW "GREASED LIGHTNING" IS GREASED

These days airplanes are flying faster and higher. The great heat created by jet engines and the extreme cold encountered at high altitudes have brought about many new grease performance problems for lubrication specialists.

Using aryl-substituted ureas for the first time as grease-thickening agents, Standard Oil scientists recently developed a new grease in cooperation with the Wright Air Development Center of the U. S. Air Force. It was made by thickening silicone oil with aryl-substituted ureas and it will lubricate bearings at high temperatures longer than any previous grease.

Standard's grease has passed laboratory tests on high-speed bearings of well over 500 hours at 450 degrees Fahrenheit. It can perform at temperatures up to 600 degrees for short periods. When ordinary greases are used under the same conditions, bearing failure soon occurs because of coke formation, oil evaporation, or excess leakage.

The new grease also lubricates effectively at temperatures as low as 40 degrees below zero. Another grease, still in the experimental stage, is being tested in the range of 65 below zero to 450 degrees above.

These developments are examples of the little known but vastly important contributions the oil industry is making to national defense.

From the laboratories of the oil industry regularly come improvements and inventions that increase America's prosperity—and strength.

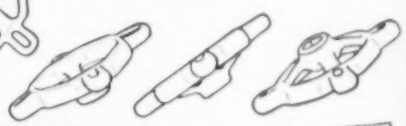
**Standard Oil Company (INDIANA)**

**WHAT TO LOOK FOR**

# when you buy a Bronze Valve

**1 LOOK FOR DESIGN.** Use the right valve for the right type of service at the right pressure. There is no such thing as an "all-purpose valve" . . . so don't try to make *one* valve do. *In the complete Lunkenheimer line, there are 125 basic bronze valves — each ideal for a certain type of service. Get your Lunkenheimer Distributor's recommendations.*

**2 LOOK FOR OPERATING FEATURES,** particularly those that make the valve longer-lasting and easier to use, such as the handwheel. *Lunkenheimer patented Non-Slip® Handwheel assures a firm, cool grip—makes it easy to close the valve tight, reducing wear and eliminating leakage. All Lunkenheimer Bronze Valves have the new Non-Slip Handwheel, along with many other exclusive operating features.*



**3 LOOK FOR A LONG-WEARING STEM,** since stem-thread wear is one of the most common causes of valve failure. *Lunkenheimer Bronze Valves have Stemalloy® Stems — an exclusive silicon-bronze alloy which completely eliminates stem-thread failure. Not one of the millions of Stemalloy Stems now in service has ever been returned because of thread wear.*

**4 LOOK FOR CLOSE-GRAINED BRONZE,** the mark of valve quality. Dense bronze not only increases the valve's strength, but makes it much more resistant to corrosion. *Lunkenheimer Bronze Valves are made of original Lunkenheimer alloys recognized by metallurgists as the highest-grade valve bronzes ever developed.*

*Remember—The Price Of A Lunkenheimer Valve Gets Smaller And Smaller And Smaller With Each Passing Year Of Dependable Service*

**ALL POPULAR SIZES** of Lunkenheimer Bronze Valves are maintained in stock for prompt delivery. Write for new Circulars 534, 582, and 574 describing typical designs. The Lunkenheimer Co., Box 360F, Cincinnati 14, Ohio.

LUNKENHEIMER L® QUALITY

**BRONZE • IRON • STEEL**

# LUNKENHEIMER®

THE ONE *Great* NAME IN VALVES

L-154-15

# DC SIGNAL TRANSMISSION

## ...a vital contribution to complete automation

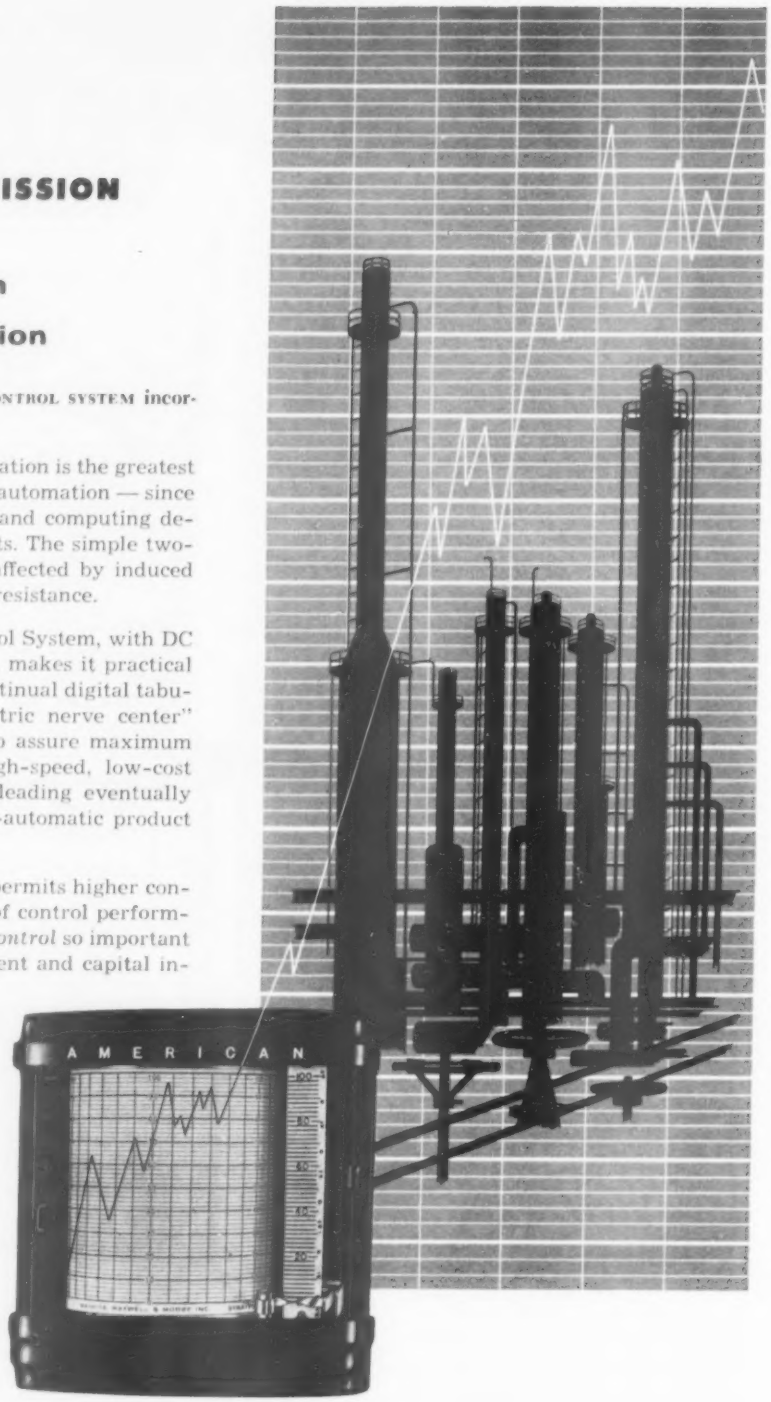
**Only the AMERICAN-MICROSEN PROCESS CONTROL SYSTEM incorporates this engineering achievement.**

DC TRANSMISSION of process information is the greatest compatability factor for complete automation — since most electronic print-out, monitoring and computing devices use DC in their measuring circuits. The simple two-wire DC communication lines are unaffected by induced alternating currents and varying line resistance.

The American-Microsen Process Control System, with DC transmission of process measurements, makes it practical to use automatic equipment for (1) continual digital tabulation of operational data; (2) "electric nerve center" supervision of all measured criteria to assure maximum safety and efficiency; (3) precise high-speed, low-cost accounting and engineering analysis leading eventually to the ultimate in automation — fully-automatic product analysis and control.

Instantaneous DC signal transmission permits higher controller gains — creates a new concept of control performance. It offers the *improved quality of control* so important in reducing the size of process equipment and capital investment for a given through-put.

The all-encompassing advantages of the American-Microsen Process Control System assure the highest reliability of instrument performance, minimum maintenance and the utmost in flexibility—all vital to the economical operation of the ultra modern plant of today and the standard plant of tomorrow. Your inquiry is invited. Write for Catalog 164.




AMERICAN
**MICROSEN INDUSTRIAL INSTRUMENTS**

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONN.

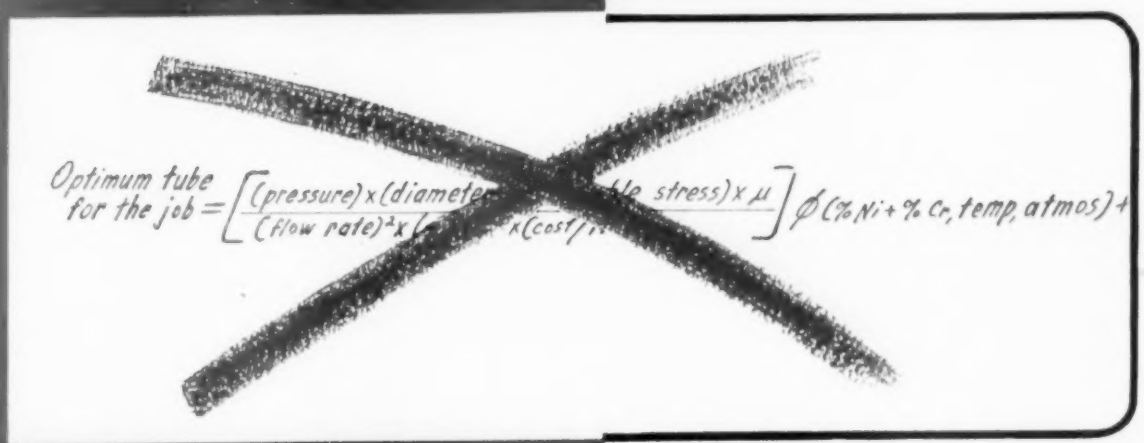
MAKERS OF 'AMERICAN' AND 'AMERICAN-MICROSEN' INDUSTRIAL INSTRUMENTS, 'HANCOCK' VALVES 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, AIRCRAFT PRODUCTS. BUILDERS OF "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

# WHEN PRESSURE IS PARAMOUNT

## Tube Selection Cannot Be Reduced to a Formula—Even a Complicated One

The choice of the optimum tubing to use in an application requiring the handling of a specific fluid at a definite working pressure involves the consideration of a number of factors. In addition to temperature, tube size, and mechanical strength of the steel, such factors as the type of fluid and corrosion resistance of the steel must be considered.

A typical case of the importance of these two factors involved an installation of Type 347 stainless steel. The tubing was exposed to chloride-bearing bayou water while conveying methanol and unreacted synthesis gases at 300F and 5000 psi. The chloride solution caused pitting corrosion. The stresses became localized at the root of the pits and reached a sufficient magnitude to cause stress corrosion and failure. Croloy 5, subsequently used, provided superior resistance to the initial pitting and satisfactory service at the desired temperature and working pressure and also at a considerable savings in cost of the tubing.




It takes an expert to specify the optimum tubing for any particular application. And there is no substitute for the kind of experience with such problems you'll find at B&W. To get the most benefit from B&W's long experience in matching tubes to jobs call on Mr. Tubes, your nearby B&W Tube Representative. He can help you.

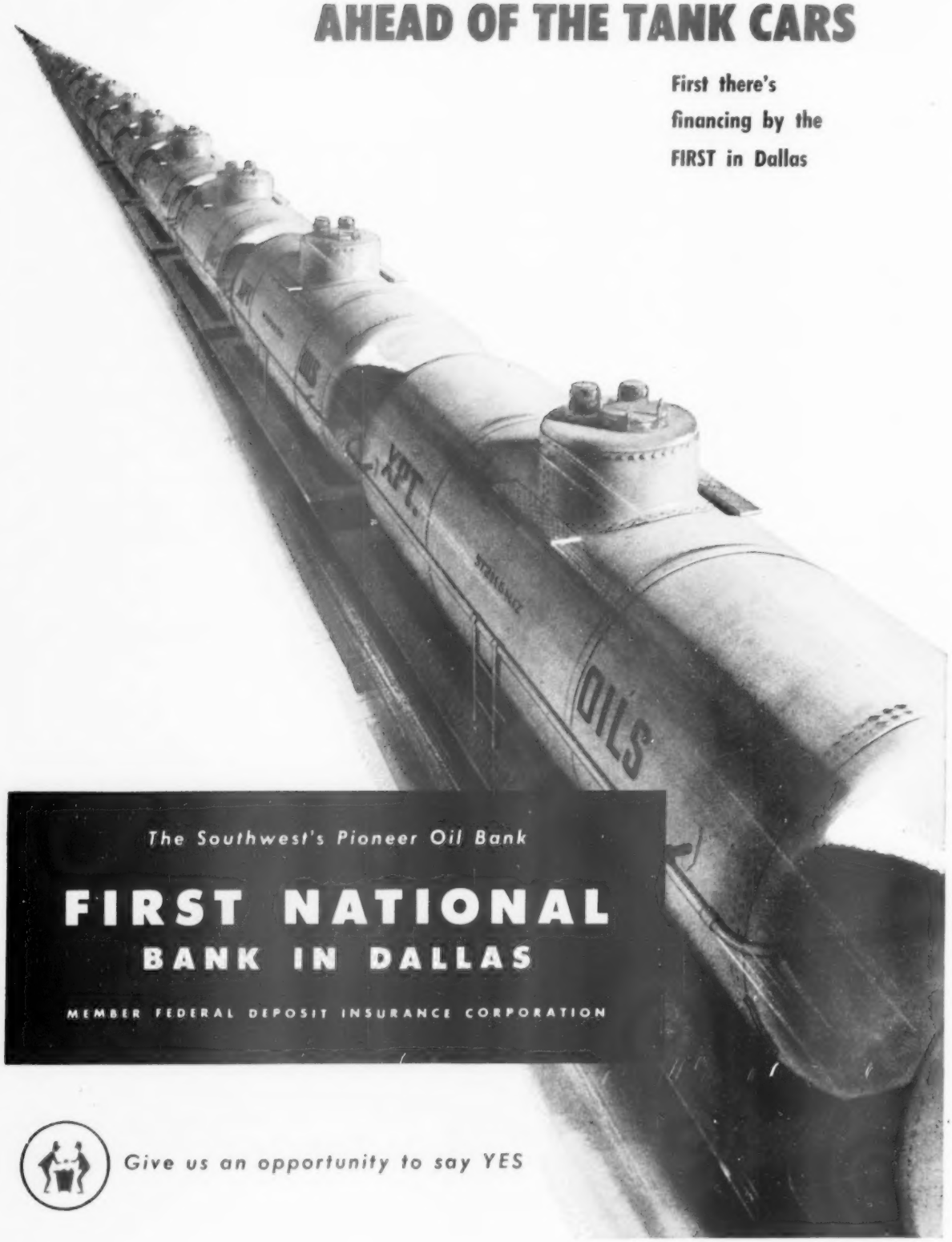
B&W SEAMLESS and WELDED TUBES

THE BABCOCK & WILCOX COMPANY
TUBULAR PRODUCTS DIVISION
Beaver Falls, Pa.—Seamless Tubing; Welded Stainless Steel Tubing
Alliance, Ohio—Welded Carbon Steel Tubing

IA-4024 (P)

# AHEAD OF THE TANK CARS

**First there's financing by the FIRST in Dallas**

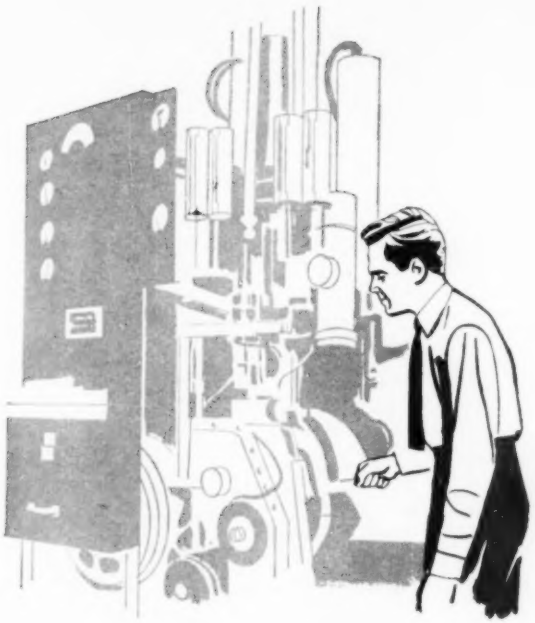



*The Southwest's Pioneer Oil Bank*

## FIRST NATIONAL BANK IN DALLAS

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

*Give us an opportunity to say YES*



If you'd like to

add 3 OCTANE NUMBERS try...

# AEROCAT®

## MS SYNTHETIC CRACKING CATALYST

Recently 42 cat crackers reported to Cyanamid the results of their cracking operations: Units on natural catalyst were getting an average of 90.5 octane (research clear). Those on AEROCAT were getting an average of 93.1 octane (research clear).

Which indicates again that where high octane is the order, AEROCAT is the answer.

This alone, of course, does not account for the fact that *among all cat crackers now using synthetic, 8 out of 10 use* AEROCAT. They use AEROCAT because:

1 AEROCAT is the surest, most economical means not only to high octane but also to

- high throughput
- low $CO_2/CO$ ratio in flue gas
- high isobutane yield
- excellent heat, steam and sulfur stability

2 AEROCAT is a product of American Cyanamid Company – which has the research facilities, the technical service staff, and the experience required to develop solutions to individual application problems.

3 Cyanamid can be relied upon as a source of supply.

How about your own cracking operations? Are you getting 93 octane . . . plus the many other AEROCAT advantages? If not, write or call Cyanamid's Technical Service representative.

AMERICAN Cyanamid COMPANY

REFINERY CHEMICALS DEPARTMENT
30 Rockefeller Plaza, New York 20, N.Y.

In Canada: North American Cyanamid Limited, Toronto and Montreal

**IMPORTANT LINK IN MECHANICAL POWER TRANSMISSION** is the Worthington QD* Sheave. Now used by all industry, the QD was developed by Worthington for the oil fields where tight shaft grip and quick detachability of sheaves is essential.
*Reg.U.S.Pat.Off.

# How the oil fields taught industry a lesson

It's hard to think of a tougher proving ground for machinery than the oil fields. Heavy shock loads and corrosion really give machine parts a workout. Take sheaves, for example. They used to be a big problem to oil men.

If the sheave was tight enough on the shaft to absorb all the shock loads, it was usually hard to get off when clutch or pump repairs were necessary. And if the sheaves came off easily, chances are they weren't on tight enough to withstand the loads.

To solve this problem, Worthington designed and developed the first sheave with a tapered, split hub. It was easy to get on, easy to get off, yet gripped the shaft tightly. Today, 15 years later, Worthington's QD (Quick Detachable) is the most widely used sheave in the world — the accepted standard in industry as well as the oil fields.

Local Worthington QD distributors in all oil-field areas are stocked-up in most sizes and they're backed up by factory stocks in Los Angeles, Fort Worth, Houston, Tulsa and New Orleans.

It'll pay you to STANDARDIZE on the Worthington QD. For more data, write for Bulletin V1400B7F to Worthington Corporation, Oil City, Pa.

MV.4.7

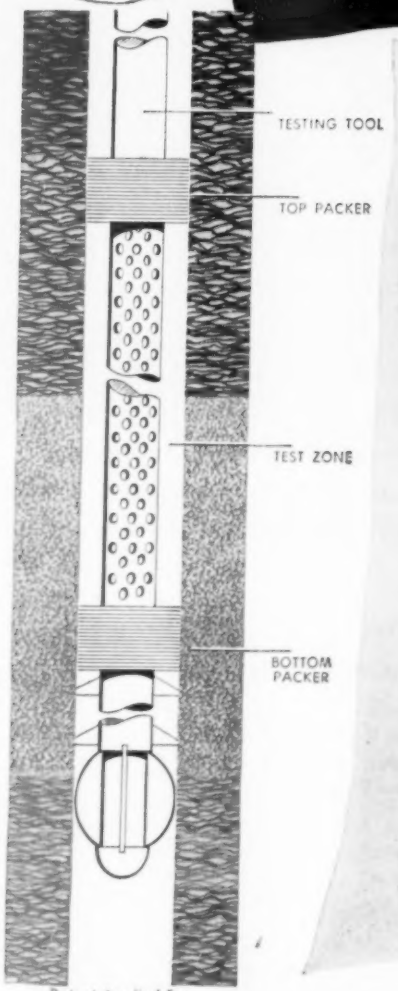
**WORTHINGTON**

**BUY THESE WORTHINGTON STANDARD PRODUCTS FROM YOUR LOCAL DISTRIBUTOR**

Compressors • Pumps • Multi-V-Drives • Variable Speed Drives

# another Johnston first!
# SELECTIVE ZONE TESTER

## Get tests at any level without tail pipe!




Patent Applied For

- Test more than one zone with a single trip in the hole!
- Eliminate cost and hazard of setting on cement plug!
- Evaluate zones passed up while drilling!
- Pin-point gas/oil and water/oil contact!
- Save rig-time and money!

**Watch for more information on Johnston's NEW . . . FIELD PROVEN SELECTIVE ZONE TESTER**

*Write for Brochure*

# JOHNSTON TESTERS

**first in drill stem testing**

**HOUSTON, TEXAS**

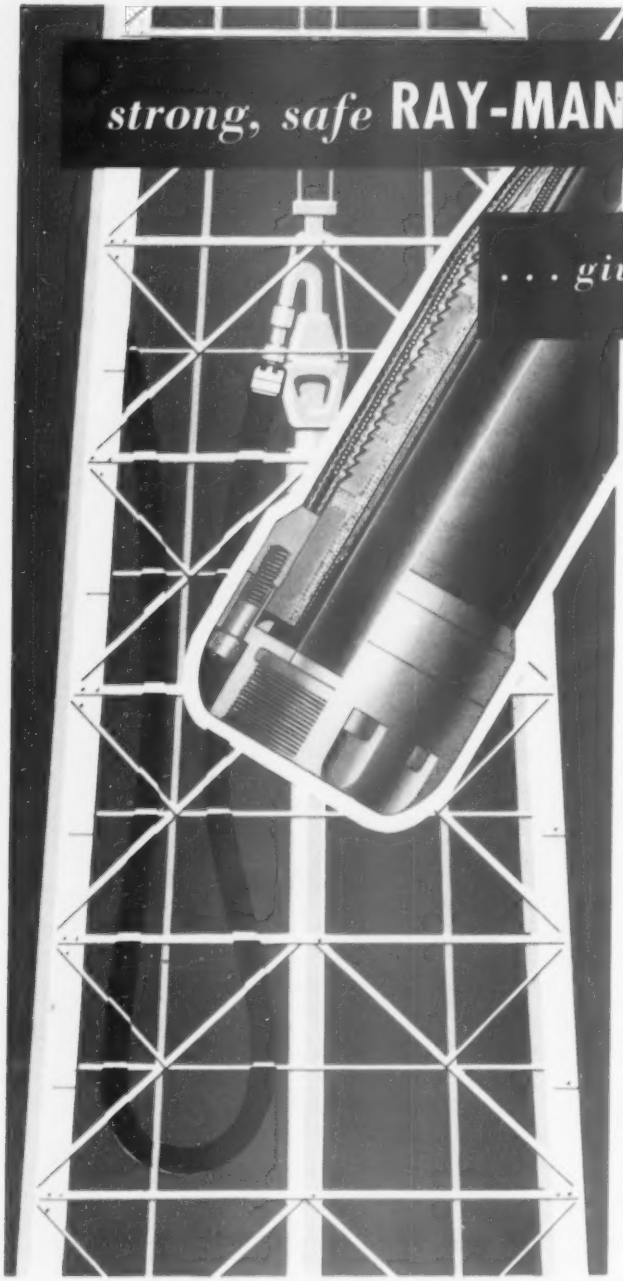
LOS ANGELES, CALIF. • CALGARY, CAN.

FORMATION AND CASING TESTING — JOHNSTON

ZT-541

# *strong, safe* RAY-MAN CBL ROTARY HOSE

## . . . *gives you more use per dollar*



Manhattan hose engineers have developed a method of winding high tensile steel cable wires under precisioned tension to produce a rotary hose unequalled for strength, flexibility and safety. This special reinforcement makes Ray-Man CBL Rotary Hose easier to handle and make up on the rig. It has higher resistance to accidental crushing. The improved streamlined built-in coupling has blow-out proof "Lip-Lok" Seal that tightens under pressure for extra safety. These features add up to lower cost, trouble-free service under all drilling conditions . . . "More Use Per Dollar" with Ray-Man CBL Rotary Hose.

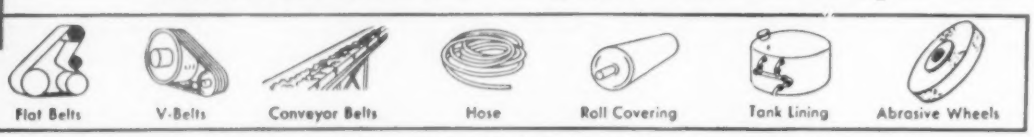
***DISTRIBUTED BY NATIONAL SUPPLY COMPANY IN ALL PRINCIPAL OIL FIELDS***

Write for your copy of Catalog 6903, describing the complete line of Raybestos-Manhattan rubber products for every phase of the oil industry; V-belts, transmission belts, oil-loading, and refinery hose. Write for your copy.

R/M

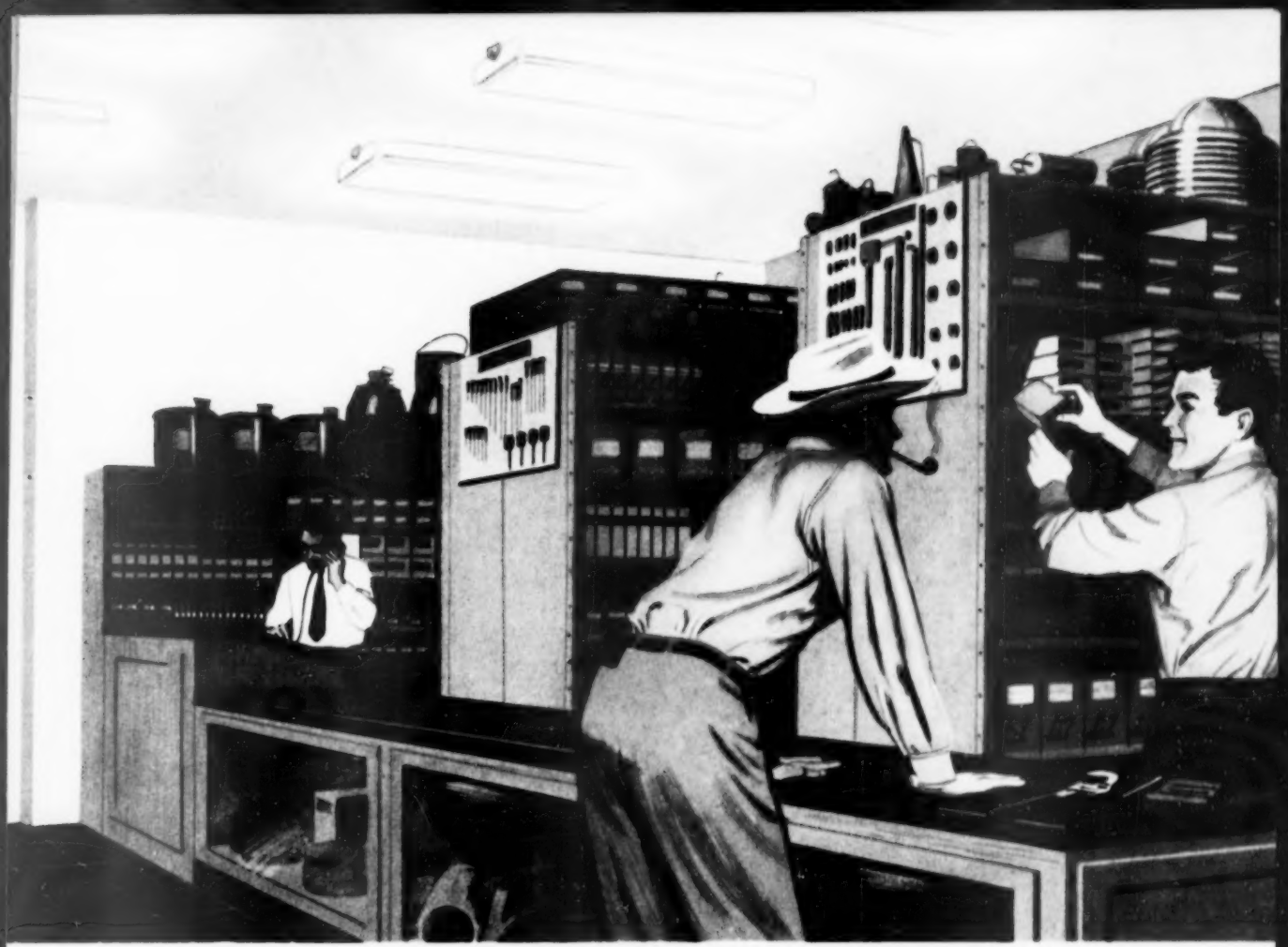
MANHATTAN RUBBER DIVISION — PASSAIC, NEW JERSEY

**RAYBESTOS - MANHATTAN, INC.**




Other R/M products include: Industrial Rubber • Fan Belts • Radiator Hose • Brake Linings • Brake Blocks • Clutch Facings
Asbestos Textiles • Packings • Engineered Plastic, and Sintered Metal Products • Bowling Balls

RM 440



# He's being fitted...for production

This typical customer in a National Supply store is ordering a variety of supply items he needs for putting several wells on production.

Although he came in with a well prepared "Want List," items on display and well-stocked shelves have served to remind him of other supply items his particular job required.

Such extended buying is common in National Supply Stores every day—mainly because the stock of every store is carefully tailored to the needs of the area and its activities. In addition, the completeness of each store's stock is implemented by the National Supply Store network which provides special supply items virtually overnight to meet a customer's requirements.

Such complete customer service has taken us from one store stocked with a few hundred items in Cygnet, Ohio, back in 1887 to today's network of 118 stores, each carrying thousands of items in stock.

It is your continued satisfaction with our supply service and quality supply items, as well as National drilling and production equipment, that keeps us the world's largest oil country supply organization. That's why complete customer service *is and always will be* our most important policy of business.

*First in quality...*
*First in supply service*
*in oil country everywhere*

NATIONAL BLUE PRODUCTS

THE
**NATIONAL SUPPLY**
COMPANY
PITTSBURGH 30, PENNSYLVANIA

*for efficient drilling at any depth...*

# IDEAL® RIGS

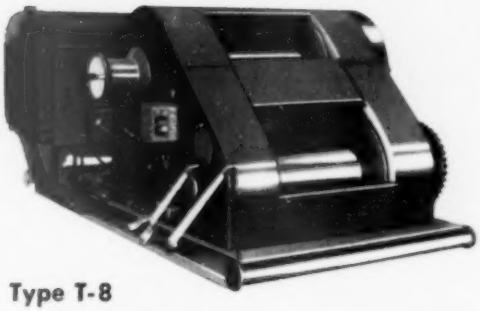
**From shallow well drilling** to the world's deepest wells, Ideal Rigs have established many outstanding performance records. To assure this performance in every Ideal Rig, National Supply's world-wide engineering, research and service staffs work constantly to provide operators with the utmost in modern rig design—in a complete range to meet every field requirement.

**You'll find the benefits** of this extensive work in such Ideal Rig features as:

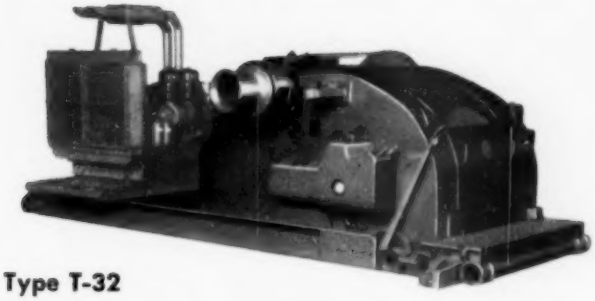
**Compact construction • Centralized air controls**
**Large-diameter drums • Simplified maintenance**

**Wherever you operate** the Ideal Rig to fit your needs, you'll find rig service and parts promptly available from National Supply—another benefit made possible by National's field supply network.

**For complete information,** ask your local National Supply Representative or Store. Ask, too, for details on the complete line of Superior Drilling Engines and Ideal Drive Groups which are built to work together with Ideal Rigs for drilling at any depth.



Type T-8

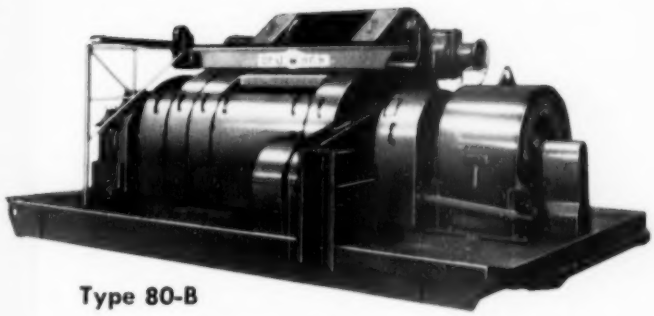


Type T-32

The Ideal T-8, National's smallest portable rig, has a servicing and workover depth range of 2,000' to 4,000'. For the T-32, National's largest rig, suitable for mobile mounting, this range is 6,000' to 11,000'.

*There's a conservatively-rated* **IDEAL® RIG** *for every drilling job!*

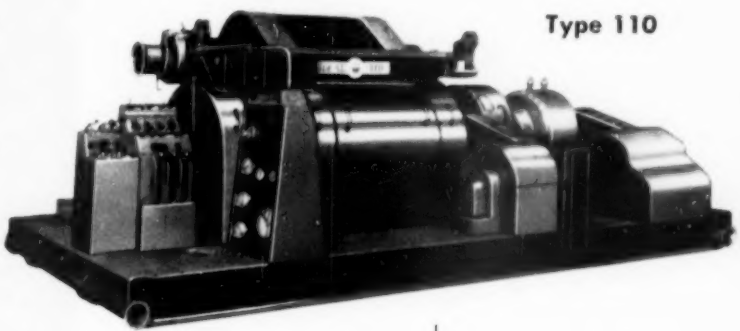
| Type | Horsepower Rating |
|---|---|
| T-8 | 80 |
| T-12 | 120 |
| T-20 | 200 |
| T-32 | 320 |
| 50-A | 450 |
| 55 | 550 |
| 80-B | 800 |
| 110 | 1100 |
| 130 | 1300 |
| 160 | 2000 |

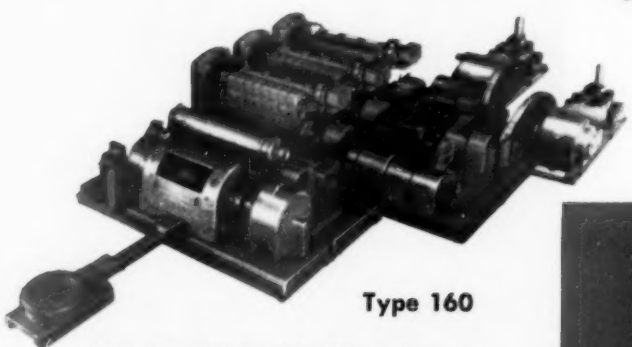


Type 80-B

Like all larger Ideal Rigs, the Type 80-B, and the Type 110 are of sectionalized design. This insures lasting factory alignment, and simplifies transportation problems.

Type 110





Type 160

The Ideal Type 160 Consolidated Rig, performance-tested on land and water, is designed to handle greater loads with more power and greater facility —for drilling deep wells at more speed.

*First in quality... First in supply service in oil country everywhere*

NATIONAL BLUE PRODUCTS

**THE NATIONAL SUPPLY COMPANY**

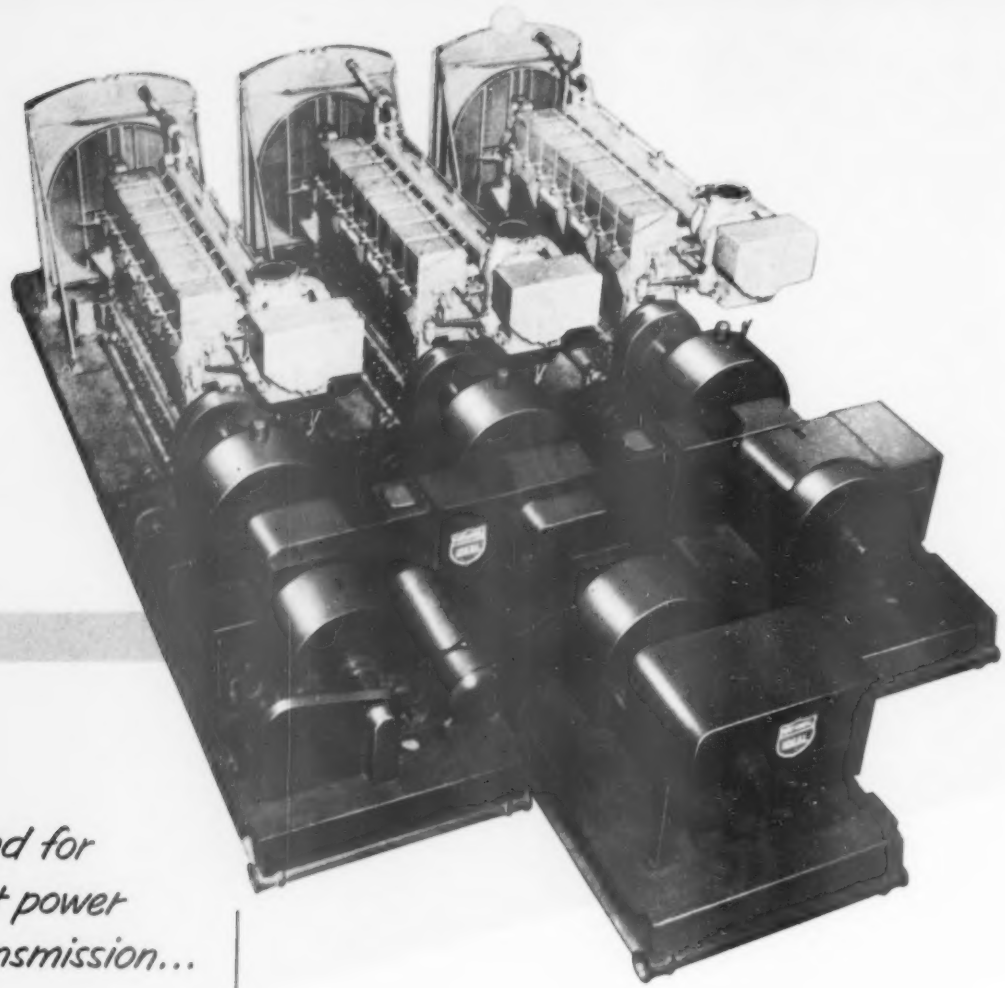
**PITTSBURGH 30, PENNSYLVANIA**

**DIVISION OFFICES:** Denver; Ft. Worth; Houston; Pittsburgh; Tulsa; Torrance

**CANADA:** The National Supply Company, Ltd., 200 6th W. Clark Building, 709 Eighth Avenue, West, Calgary, Alberta

**EXPORT:** 600 Fifth Avenue, New York 20, N. Y., U. S. A., River Plate House, 12 South Place, London E. C. 2

**for rig drives designed for top efficiency - see *next page***



*...and for efficient power transmission...*

## *...integrally designed* IDEAL® DRIVE GROUPS

**Ruggedly built,** compact and easy to transport, Ideal Drive Groups provide efficient, dependable power transmission under all drilling conditions. In designing and building Ideal Drive Groups for modern field requirements, National Supply has developed an exceptionally wide range of flexible power equipment for long, economical service.

**You'll find it worthwhile** to get complete details on these outstanding features of Ideal Drive Groups—

**Sectionalized construction,** with each section a completely and accurately aligned portable unit

**Wide power range,** with engine and drive combinations from 400 to 2000 horsepower

**Slush pump drives,** both independent and integral types, for every fluid requirement

**Three types of transmissions**—a choice of mechanical, Ideal Gyrol, or National Torque Converter

**Product bulletins** on Ideal Drive Groups, Ideal Independent Pump Drives and Superior Gas and Diesel Drilling Engines are yours for the asking at the nearby National Supply Store.

NATIONAL BLUE PRODUCTS

*First in quality...*
*First in supply service*
*in oil country everywhere*

**THE NATIONAL SUPPLY COMPANY**
**PITTSBURGH 30, PENNSYLVANIA**

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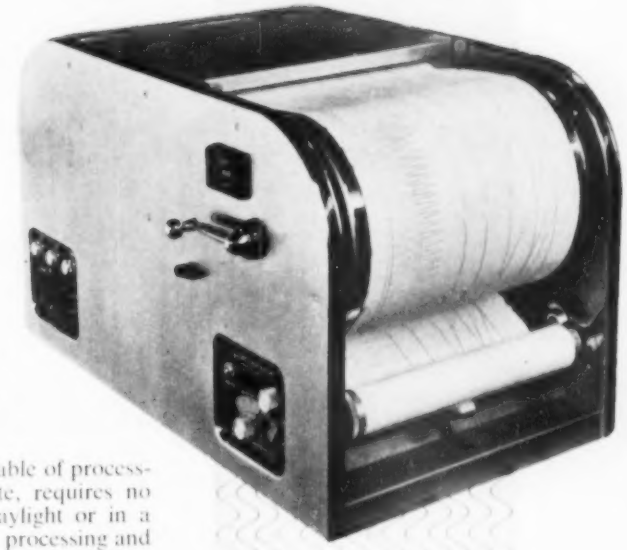
NATIONAL OIL FIELD MACHINERY AND EQUIPMENT • SPANG STEEL PIPE • SUPERIOR & ATLAS ENGINES

# New, compact photo-record processor

## for paper oscillograms and other rolled paper photo-records



THE TEST ENGINEER'S DILEMMA—how to develop and dry large quantities of test data on rolled sensitized paper—is solved by Consolidated's new Type 23-109 Oscillogram Processor. Built for operation at the actual testing site, this self-contained instrument, capable of processing records as rapidly as 15 feet per minute, requires no external water supply and can be used in daylight or in a normally illuminated room. Simplified loading, processing and unloading techniques permit operation by personnel without previous photo-lab experience. The Type 23-109 processor is compact, portable and fast, requiring only electric power for the paper-transport motor and the drying drum. Where the problem is to save time in processing voluminous test data on photo-record paper, CEC's new oscillogram processor is the practical answer. Write for Bulletin CEC 1537A-X1.

### Consolidated Type 23-109

- Reduces time lag between test and interpretation of data.
- Requires no dark room for operation.
- Built for testing-site use without external source of water.
- 250 foot capacity for photo-record paper up to 12" widths.
- Thermostatically controlled solution temperature.
- Automatic squeegeeing for longer solution life.
- Cumulative processed-footage indicator.

*Loading of the magazine is easy. Processing of paper in varying widths to 12" is handled by simple, adjustable guides.*

*Threading the processor is simple. Insertion of the roller racks threads the short leader quickly and easily.*

## Consolidated Engineering

CORPORATION

300 North Sierra Madre Villa, Pasadena 15, California

*Sales and Service through* **CEC INSTRUMENTS, INC.,** *a subsidiary with offices in: Pasadena, New York, Chicago, Washington, D. C., Philadelphia, Dallas.*

ANALYTICAL INSTRUMENTS FOR SCIENCE AND INDUSTRY

# *We admit it...your business is different*

*3-Dimension Metallurgical Service*

That's why we offer a unique metallurgical service to all manufacturers who have steel problems. We know that steels behave in different ways, in different plants, depending upon what your operations are. We know that the solution, whatever it is, must be tailor-made for your production setup.

Our field metallurgist, the first man on this team, goes right into your plant to find out the facts about your particular problems. He talks to your production men and engineers, makes notes.

Information he gathers is discussed with Republic mill and laboratory metallurgists. All three men then focus their combined knowledge of alloy steels, heat treatment, forging and fabrications on your problem. The recommendation they come up with is based on your costs and your equipment.

Many manufacturers who have used this Republic 3-D Metallurgical Service have found ways to increase production, make better products, and cut costs. Perhaps you can achieve these same benefits. A call to your nearest Republic office will start the ball rolling.

**REPUBLIC STEEL CORPORATION**
*Alloy Steel Division • Massillon, Ohio*
**GENERAL OFFICES • CLEVELAND 1, OHIO**
Export Department: Chrysler Building, New York 17, N. Y.

**REPUBLIC ALLOY STEELS**

**Other Republic Products include Carbon and Stainless Steels—Sheets, Strip, Bars, Wire, Pig Iron, Steel and Plastic Pipe, Bolts and Nuts, Tubing**

# Have you compared costs of weed control lately?

*It's economical because it's simple and long-lasting when you use*

## Du Pont "Telvar" W

Weed Killer

Around tanks and other key areas "Telvar" W gives long-term control of vegetation . . . which reduces fire hazards.

One spraying of as little as 40 to 60 pounds of Du Pont "Telvar" W per acre can get rid of vegetation *for a growing season or longer!* This powerful weed killer kills through the roots . . . remains in the ground to prevent new growth. Its lasting chemical action is just what's needed around wells, tank farms, refineries, pumping stations and pipelines.

### Savings for You

With "Telvar" W on the job, you'll save labor and maintenance costs. A single spraying takes the place of laborious cutting and mowing . . . expensive multiple spraying. You eliminate the problem of storing and handling bulky weed killers, too. It all adds up to new efficiency in weed control—new economy in keeping key areas neat and trim.

### Easy and Safe to Use

"Telvar" W is a wettable powder that mixes readily with water and is low in toxicity to humans and animals. Non-volatile and non-corrosive, it can easily be applied by standard spraying equipment. And "Telvar" W is non-flammable—particularly important in oil-field application.

### Your Custom Sprayer Can Help

Specify "Telvar" W for this year's weed-control program. If you don't have spraying equipment, get in touch with a reliable custom sprayer to do your weed killing on an annual basis.

We can help you contact the Custom Sprayer in your area and give you more information on Du Pont "Telvar" W Weed Killer.

*Mail This Coupon for Free Booklet*

E. I. du Pont de Nemours & Co. (Inc.)
Grasselli Chemicals Department, Rm. D-4026
Wilmington 98, Delaware

☐ Please send me your booklet describing positive weed control with "Telvar" W. ☐ Send me the name of my nearest supplier.

Name_____ Position_____

Firm_____

Address_____

City_____ State_____

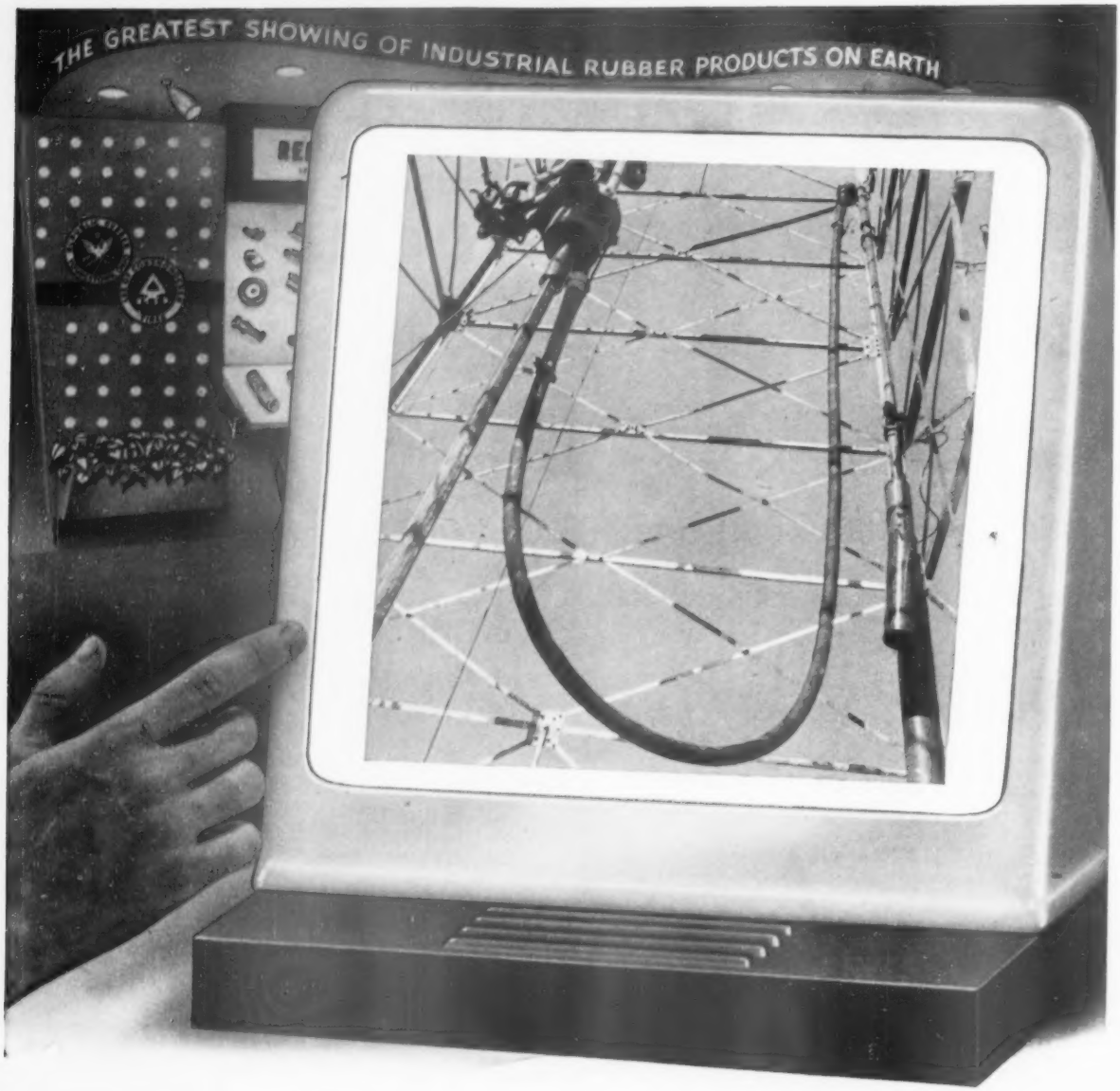
DU PONT **TELVAR W**

REG. U.S. PAT. OFF. TRADE MARK

*Weed Killer*

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

*On all chemicals always follow directions for application. Where warning or caution statements on use of the product are given, read them carefully.*




# "CHAMPION" For A Champion

Your rig can be a champion, too! . . . a champion in efficiency and low-cost operation . . . a champion tour after tour, with fewer breakdowns and better production records. How? SPECIFY Republic's Champion Rotary Drilling Hose . . . a rotary drilling hose that will earn its right to work on your rig.

Champion Rotary Drilling Hose is designed to stand up longer under high, pulsating pressures. There are no bolts or flanges to catch on the rigging. The special flush-fitting, streamlined couplings, **hydraulically locked into** the hose carcass, will not leak or work loose.

Your specialized Republic Oil Field Distributor can show the way to operating economy with Industrial Rubber Products. Call him soon or write directly to us.

MID-CONTINENT DISTRIBUTOR
Jones & Laughlin Steel Corporation, Supply Division
P. O. Drawer 2481, Tulsa 2, Okla.

**REPUBLIC RUBBER DIVISION**
LEE RUBBER & TIRE CORPORATION, YOUNGSTOWN 1, OHIO
INDUSTRIAL RUBBER PRODUCTS

WEST COAST DISTRIBUTORS
Hendrie Belting & Rubber Co.
405 Towne Ave., Los Angeles, Calif.
Pacific Coast Rubber Company
51 Main St., San Francisco, Calif.

# FLOATING ON HYATTS!

**This is a job for straight roller bearings, and EMSCO relies on HYATTS!**

Take a good look at these herringbone gears—and at the four bearings supporting the two smaller shafts. These particular herringbones operate in the gear box of EMSCO's newest pumping unit, and the bearings are *Hyatt Hy-Loads!* For oilmen, this is a combination that means longer bearing life and lower maintenance costs, because only *straight radial bearings* permit these gears to locate themselves for most efficient operation. And when the application calls for radial-type bearings, EMSCO engineers specify Hyatts. Hyatts offer the proven advantages of easy assembly, simple maintenance, complete interchangeability of parts, and longer life. Insist on Hyatt Bearings for *your* oil-field equipment.

**HYATT ROLLER BEARINGS**

STRAIGHT ◯ BARREL ◯ TAPER ◯

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION • HARRISON, NEW JERSEY

# We tie truck axles in

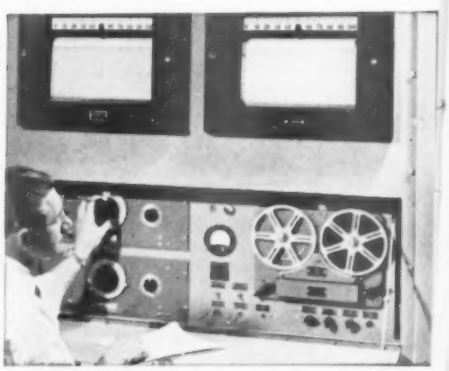
## *in the new Timken-Detroit indoor proving ground . . . and only*

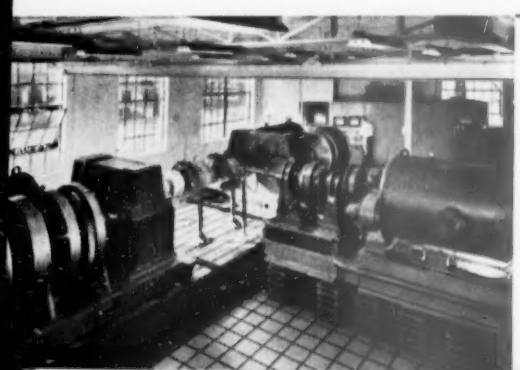
**We twist, shock-load, abuse, and torture them. Match every conceivable hauling condition. Then add a few brutal tricks of our own!**

**Why?** So you'll know in advance, and *for sure*, that a Timken-Detroit axle can take the punishment it was designed for. More rugged, grueling punishment than any other axle made!

To prove it, we capsuled a multi-thousand acre proving ground into one room. Here our engineers can put 50 years of experience in building axles for trucks, buses and trailers to work—subjecting axles and gearing *indoors*, to any *outdoor* operating condition.

Such exacting research pays off for you in: longer axle life; less maintenance, repairs and downtime; reduced operating expenses. This is why Timken-Detroit axles are preferred by manufacturers and operators everywhere.





**How TDA proves axle quality in this "Torture Chamber"**

We pick one of our axles at random . . . then duplicate a hauling condition, hour after hour, day after day . . . simulating half a million miles of the toughest driving situations in just a few days. Or "invent" a test like going uphill with a full load from California to New York nonstop. There is no other axle testing like it in the world!

**This is our "truck driver."** He works in our "Torture Chamber." Above him are graphs showing speed and torque performance under any operating condition he chooses . . . soft ground at full load . . . mountains . . . express highways or side roads. With special dials, recorders and electronic devices, he actually *drives* the axle with scientific accuracy from his chair!

**Hauling pipe?** It's good to know you're riding on genuine Timken-Detroit axles—duplicates of axles that have been given the "works" in our indoor proving laboratory. Simulating your toughest hauling problems—over bumpy, twisting roads under full load over express highways—and in a few days duplicating 500,000 miles of abuse. It's done to save you money on maintenance and repairs—make you more money every load.

**You haul gas—on schedule!** And you're *sure* with Timken-Detroit axle shafts. Proved capable of being twisted 14°—forward and backward—36 times a minute, 24 hours a day, for days on end. Only Timken-Detroit "Torture-Tested" axles can take this brutal treatment—assure you top performance—make you more money per load.

# knots

## Timken has it!

TIMKEN Detroit AXLES

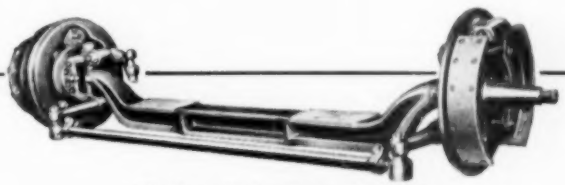
TIMKEN-DETROIT AXLE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
DETROIT 32, MICHIGAN

The Accepted TDA Standard

TRADE MARK REGISTERED

**"TORTURE-TESTED"**
***to Save Money on the Job***

**WORLD'S LARGEST MANUFACTURERS OF AXLES FOR TRUCKS, BUSES AND TRAILERS**

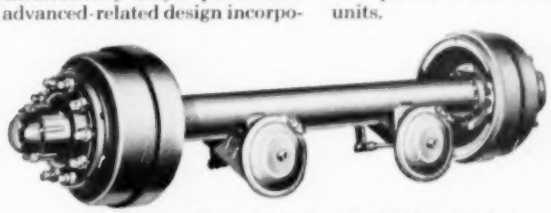


**Timken-Detroit Front Axles**

Here is easy, positive steering control. A little man can handle a large rig with TDA front axles as easily as a big 210-pound, six-footer, at fast or slow speeds...on smooth or rough roads. No wheel kickback. Tractor semi-trailer hook-ups have smallest possible turning radius—greatest maneuverability.

**Timken-Detroit Hypoid Gearing**

Hypoid gearing for truck axles was pioneered by Timken-Detroit. And only Timken-Detroit has Hypoid gearing in a complete "family" of 7 basic axle capacities—in the entire range of medium and heavy-duty requirements. This advanced-related design incorporates the same features of construction and interchangeability in a choice of 3 types of Hypoid final drives using the same axle shafts—single-speed; single-speed double-reduction; and two-speed double-reduction final drive units.

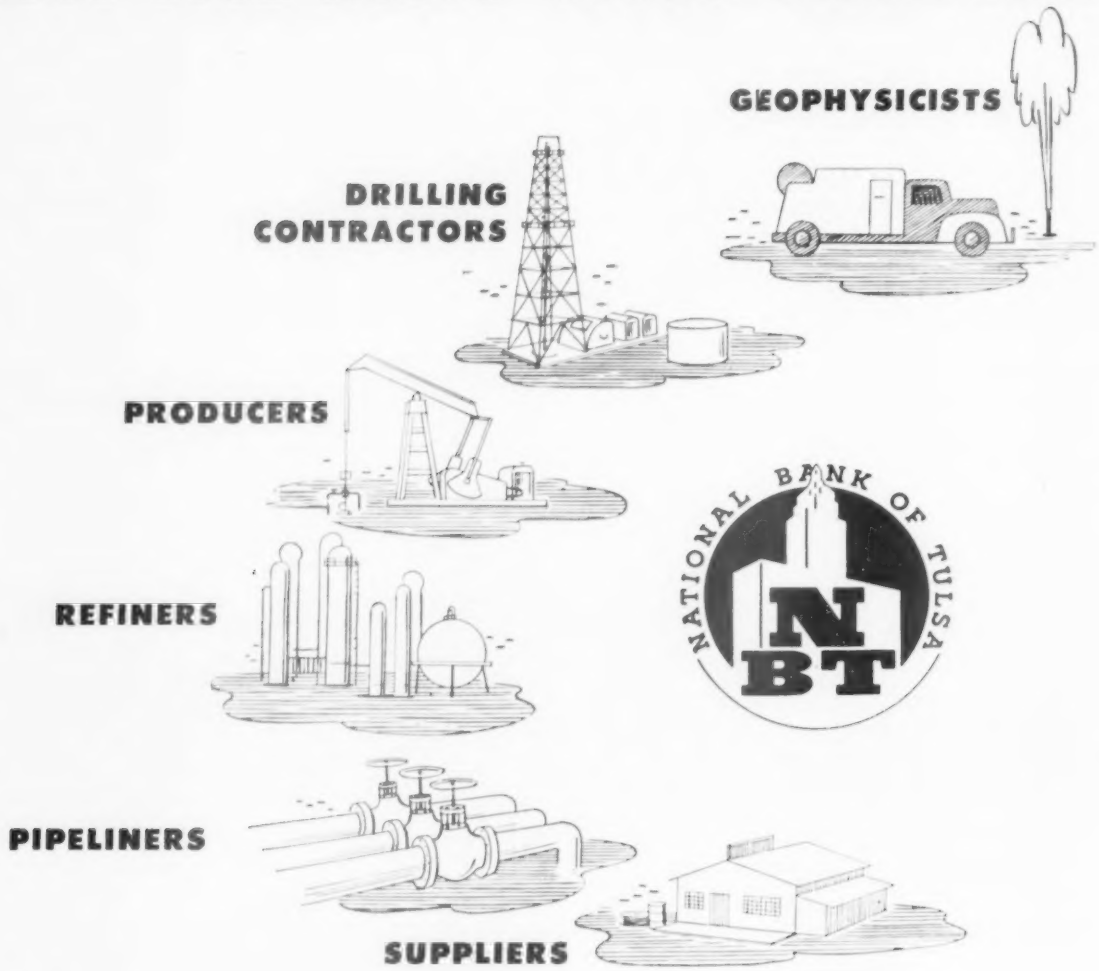


**Timken-Detroit Tubular Trailer Axles**

The lightest weight tubular trailer axle made. Produced in the largest, most modern axle plant in the world. *PLUS* exclusive features: Lightweight Fabricated Brake Shoes with Econoliners for greater wear, longer service, Electrically Welded Spindles and Spring Seats guaranteed for life, Nylon Bushings in Brake Camshaft Assemblies.

*Plants at: Detroit, Michigan*
*Oshkosh, Wisconsin • Utica, New York • Ashtabula, Kenton and Newark, Ohio • New Castle, Pennsylvania*

# ASK THE MEN WHO KNOW...



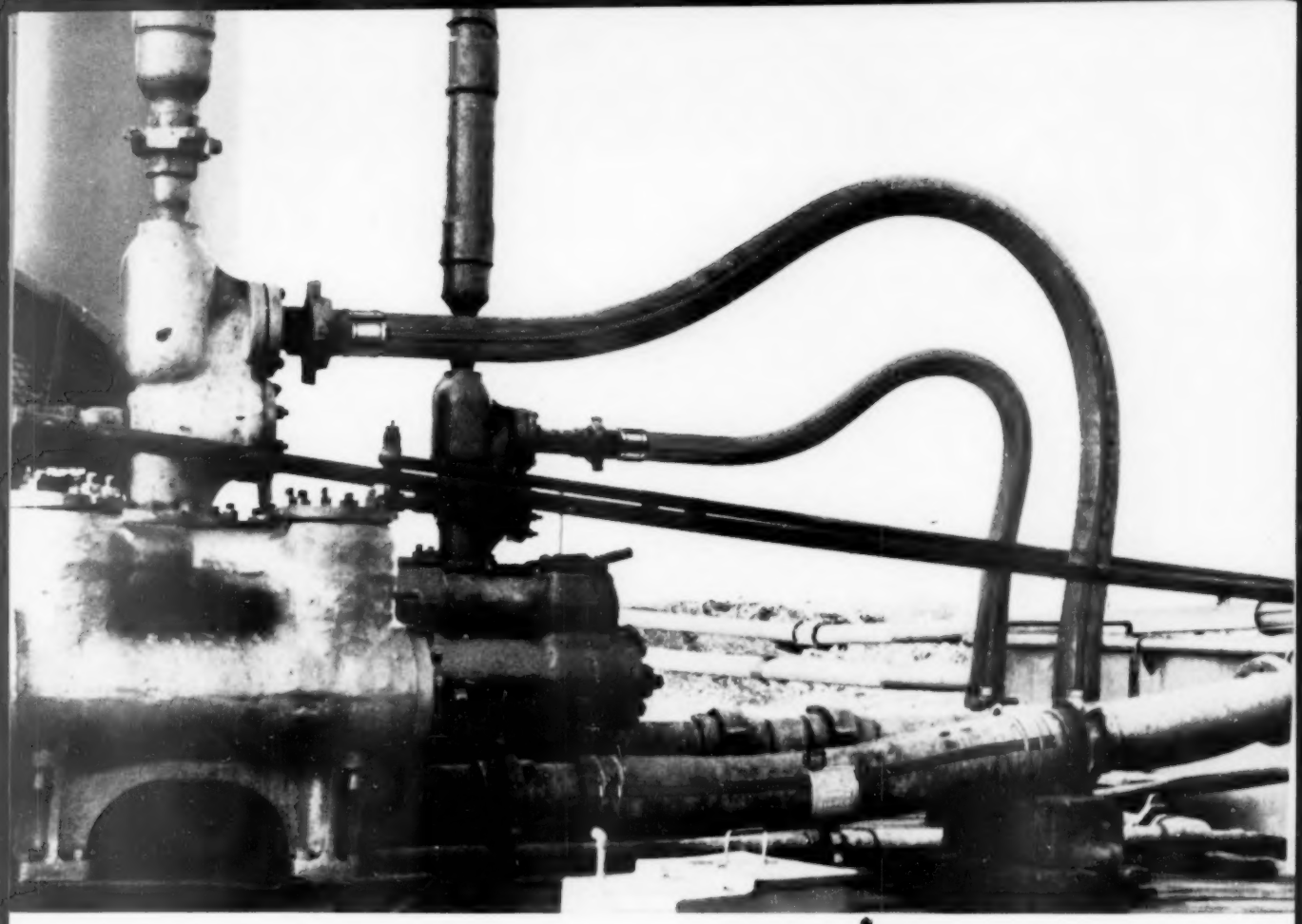

## About NBT Oil Loans

Oil men in every phase of the industry are familiar with National Bank of Tulsa oil financing services. Wherever your operations may be, and in whatever segment of the industry you may be operating, it will pay you to investigate this specialized service at "The Oil Bank of America."

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

**NATIONAL BANK OF TULSA**

*The Oil Bank of America*



# Thermoid Oil Field Products Are Built for Rugged, Continuous Service ...to Cut Your Drilling Costs

Thermoid Industrial Rubber Products — Quality Service

**Thermoid Flexible Discharge Units** provide rugged high pressure connections between mud pump and standpipe . . . eliminate sharp angle fittings, thus reducing turbulence and loss of pressure. Easily installed, they take up misalignment, save rig up and tear down time, resist vibration, cut time lost due to pipe breakage and loosened connections. Full flow pressure seal couplings are built in. Supplied in diameters of $2\frac{1}{2}$", 3" and $3\frac{1}{2}$" . . . standard lengths. Pre-tested to 5000 psi to assure blowout-proof performance.

**Thermoid Mud-Flo Suction Hose** absorbs pumping vibration and affords maximum flexibility. Thick inner tube and heavy galvanized wire reinforcement imbedded in rubber compound prevents collapse and provides unobstructed flow. Permits changing position of intake without changing connections. Cover withstands abrasion and weathering. Ends are sealed to help keep out moisture.

To keep your costs down, be sure you specify Thermoid Flexible Discharge Units and Mud-Flo Suction Hose.

*Mid-Continent Offices and Warehouse, Houston, Texas*
*California Offices and Warehouse, Los Angeles*

Flexible Discharge Unit

Mud-Flo Suction Hose

SEE OUR CATALOG IN THE COMPOSITE CATALOG

**Thermoid**

Powerflex Rotary Hose • Trioflex Slim-Hole Rotary Hose • Mud-Flo Slush Pump Hose • Flexible Discharge Units • F.H.P. and Multiple V-Belts • Oil Country Flat Belting

Wire Line Turn Backs • No-Wip Line Savers • Stuffing Box Rings • All Types of Hose • Molded Specialties • Brake Blocks

Thermoid Company • Offices & Factories: Trenton, N. J., Nephi, Utah

ACCO products

# New 10,000 psi Rating for R-P&C Bar Stock Valve

New structural improvements in R-P&C's popular **Fig. 1040-A** carbon steel bar stock valve have resulted in substantially higher ratings for these rugged close control valves. New ratings range from 10,000 psi at 150°F to 475 psi at 1000°F. Sizes from ⅛" to 1". Each valve passes a hydrostatic test at 15,000 psi before leaving the factory.

R-P&C bar stock valves can supply an inexpensive, dependable answer to many of your valve application problems—particularly if these involve throttling or other close control service, high temperatures or high pressures. They are uniquely adapted for meter, gauge or instrument service or in crowded applications such as panel boards.

Fifteen different Fig. numbers in R-P&C's complete bar stock line provide close flow control for a wide variety of fluids. Pressure and temperature ratings, which vary for different materials and constructions, cover an extensive range. Among special applications covered are—

**for Corrosion Resistance:**

R-P&C Bar Stock valves are manufactured in 12-14% chromium stainless steel, and 18-8 molybdenum stainless steel for use with corrosive fluids—also particularly applicable for sub-zero service.

**for Severe Throttling Service:**

**Fig. 1060-S** Bar Stock valves have special discs of STELLITE—providing resistance to abrasion by cutting particles in extremely severe throttling service such as continuous blow-down with steam, water or other fluids.

**for Close Quarters, Unusual Piping Hook-ups:**

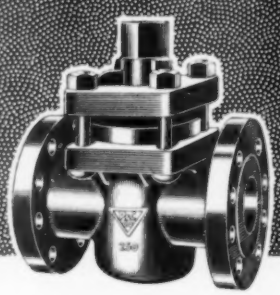
The adaptability of R-P&C Bar Stock valves solves installation problems. These versatile valves are supplied in globe and angle styles with female ends, male and female ends, or male union ends. Also provided with welding or silver-soldering ends for welded piping systems. Special lock bonnets provide additional protection in applications involving constant vibration.

*Write* TODAY FOR CATALOG

**Pressure sealed bonnet joint cast steel valves** are furnished in gate valve and globe valve styles in 900 lb., 1500 lb., and 2500 lb. pressure classes.

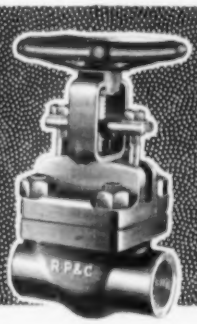
**Lubrotite Gate Valves,** exclusive with R-P&C, provide a patented lubricant seal which gives positive shut-off, retards corrosion, reduces maintenance. Furnished in iron, iron with bronze trim, cast steel with stainless trim, in sizes from 2" to 24".

**Cast steel fittings,** ells, tees, laterals, crosses, reducers—screwed or flanged ends. Furnished in a wide variety of sizes up to 24", in pressure classes from 150 to 2500 lbs.



**Asbestos-packed cocks,** an R-P&C exclusive, are furnished in iron in sizes from ¼" to 6" with screwed or flanged ends.

**Fig. 212 screwed end bronze check valve** typifies R-P&C's complete check valve line—furnished in iron, bronze or cast steel in sizes ranging from ¼" to 24".

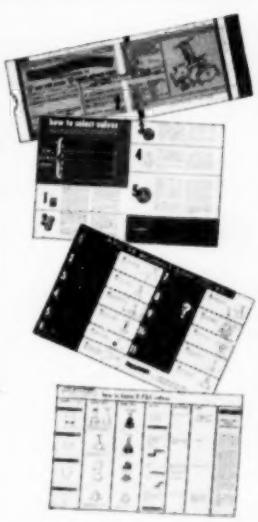


**Forged steel gate valves,** like Fig. 6056 above, are offered in sizes from ¼" to 2" with flanged, screwed or welding ends. Pressure ratings range from 2000 psi at 100°F to 380 psi at 1000°F.

# Which of these FREE TECHNICAL AIDS do you want?

R-P&C manufactures a *complete* line of valves—the units above only begin to indicate the comprehensiveness of the R-P&C line. In addition R-P&C supplies complete technical assistance—provides every possible aid to assist the buyer in valve selection, installation and operation. A few of these technical aids are shown at right.

***Any of the above technical aids furnished promptly on request. Write R-P&C Valve Division, American Chain & Cable, Reading, Pennsylvania.***



**VALVE SELECTOR SLIDE RULE**
Handy selector slide rule gives all dimensions for iron body valves, steel valves in 150, 300, 400, 600, 900 and 1500 lb. classes.

**HOW TO SELECT VALVES**
17" by 11" wall chart lists principles to use in selecting valves for various applications . . . considers effects of fluids, temperatures, pressures, sizes and service requirements. Glossary of valve terms included.

**HOW TO PROTECT YOUR VALVES**
17" by 11" wall chart lists 22 installation and operation pointers to protect valves, get maximum life. Includes glossary of valve terms.

**HOW TO KNOW VALVES**
17" by 11" wall chart graphically shows appearance, construction, operation, recommended applications for gate, globe and check valves, cocks. Also National Safety Council operating recommendations.

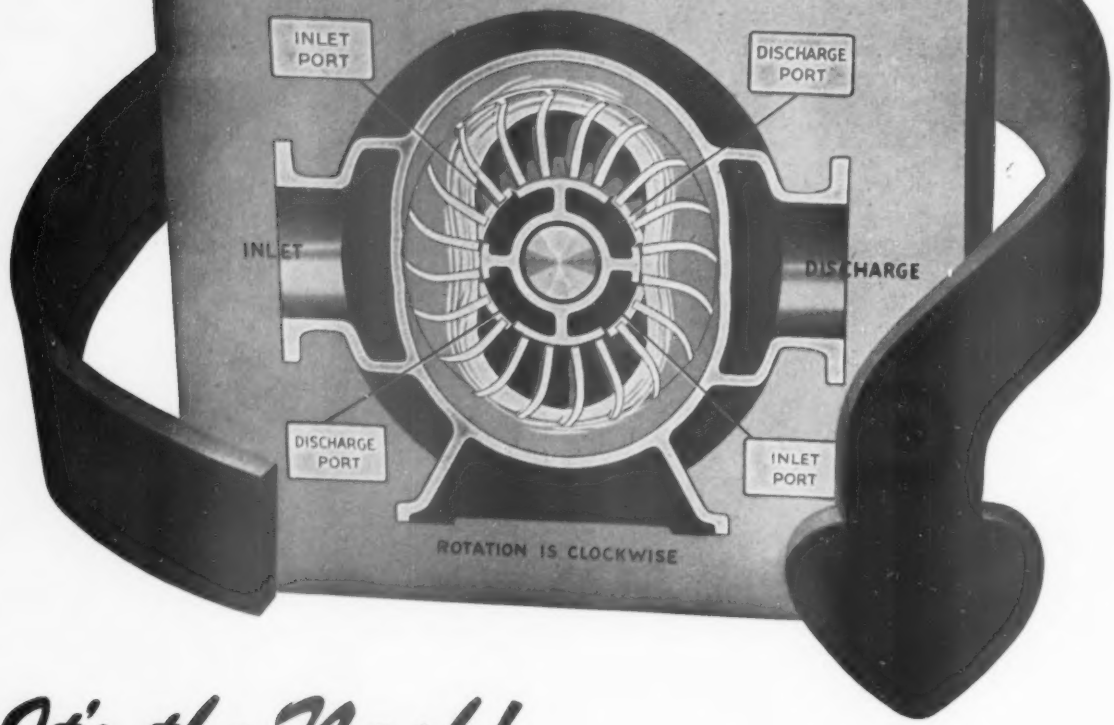
ACCO
TRADE MARK

**R-P&C Valve Division**
**AMERICAN CHAIN & CABLE**

Reading, Pa., Atlanta, Baltimore, Boston, Chicago, Denver, Detroit, Houston, New York, Philadelphia, Pittsburgh, San Francisco, Bridgeport, Conn.

**R-P&C valves**

# This is Why the Nash is the Most Simple Compressor




# *It's the Nash!*

There are no mechanical complications in a Nash Compressor. A single moving element, a round rotor, with shrouded blades, forming a series of buckets, revolves freely in an elliptical casing containing any low viscosity liquid. This liquid, carried with the rotor, follows the elliptical contour of the casing.

The moving liquid therefore recedes from the rotor buckets at the wide part of the ellipse, permitting the buckets to fill with gas from the stationary Inlet Ports. As the casing narrows, the liquid is forced back into the rotor buckets, compressing the gas, and delivering it through the fixed Outlet Ports.

Nash Compressors produce 75 lbs. pressure in a single stage, with capacities to 6 million cu. ft. per day in a single structure. Since compression is secured by an entirely different principle, gas pumping problems difficult with ordinary pumps are often handled easily in a Nash.

Nash simplicity means low maintenance cost, with original pump performance constant over long periods. Data on these pumps sent immediately on request

- No internal wearing parts.
- No valves, pistons, or vanes.
- No internal lubrication.
- Low maintenance cost.
- Saves floor space.
- Desired delivery temperature automatically maintained.
- Slugs of liquid entering pump will do no harm.
- 75 pounds in a single stage.

**NASH ENGINEERING COMPANY**
**313 WILSON, SO. NORWALK, CONN.**

# LUFKIN *Presents*

## A new member of an ever increasing family of superior pumping equipment

*the NEW*
**LUFKIN AIR BALANCED PUMPING UNIT**

COMPLETELY ENCLOSED AIR SYSTEM. PATENTED SEALING ARRANGEMENT INSURES MINIMUM LOSS OF AIR.

SIMPLE DEVICE AUTOMATICALLY CONTROLS AIR PRESSURE FOR VARIABLE COUNTERBALANCE REQUIREMENTS KEEPING WELL PERFECTLY BALANCED AT ALL TIMES.

**SIMPLE** ▶ FOR EASY OPERATION AND MAINTENANCE

**RUGGED** ▶ FOR DEPENDABILITY AND TROUBLE FREE SERVICE

**COMPACT** ▶ FOR ECONOMICAL TRANSPORTATION AND INSTALLATION

● A COMPLETE RANGE OF API SIZES FROM 114 THRU 912

*Lufkin* **FOUNDRY & MACHINE COMPANY**
**LUFKIN, TEXAS**

*Branch sales and service* Houston, Dallas, New York, Tulsa, Los Angeles, Seminole, Oklahoma City, Corpus Christi, Odessa, Kilgore, Wichita Falls, Casper, Wyoming, Great Bend, Kansas, Effingham, Illinois, Duncan, Oklahoma, Brookhaven, Mississippi.

Lufkin Equipment in CANADA is handled by
**THE LUFKIN MACHINE CO., LTD., 14321 108th Avenue, Edmonton, Alberta, Canada.**

# HOW'S THIS FOR OS&D HOSE PERFORMANCE?

Tanker loading conditions are particularly severe at the Union Oil Company's Port San Luis Wharf, Avila, California. When heavy seas are running, tankers must be held some 75' to 100' away from the dock with the aid of four heavy mooring buoys plus the ship's anchor. In spite of these conditions, Hewitt-Robins Smooth Bore Oil Suction & Discharge Hose performs with maximum efficiency.

Normal life expectancy for loading hose at this installation is 15,000,000 barrels, yet a single line of Hewitt-Robins Smooth Bore OS&D Hose has handled over 37,000,000 barrels to date. Here again, a customer's performance record has shown that for longer hose life and more economy in operation the first and best choice is Hewitt-Robins Hose.

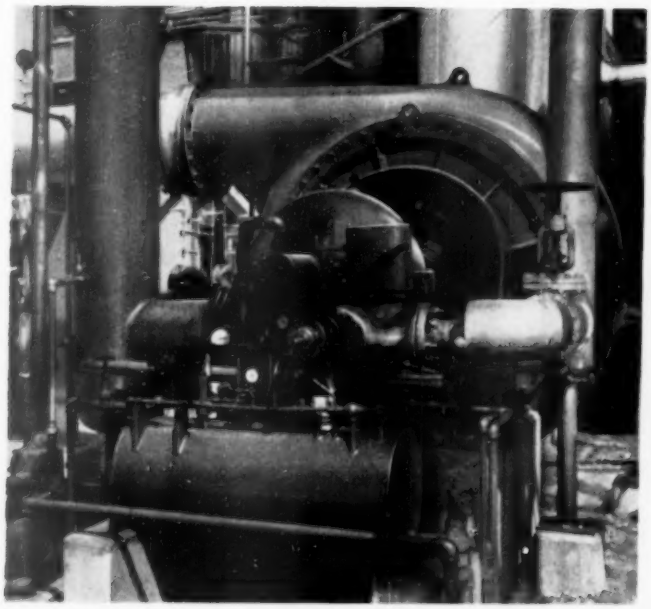
*For immediate information regarding Hewitt-Robins OS&D Hose or* any *Hewitt-Robins industrial hose contact your local Hewitt Rubber Distributor (See "Rubber Products" Classified Phone Book.)*

**HEWITT HR ROBINS**

**Executive Offices, Stamford, Connecticut**

**DOMESTIC DIVISIONS:** Hewitt Rubber • Robins Conveyors • Robins Engineers • Restfoam
**FOREIGN SUBSIDIARIES:** Hewitt-Robins (Canada) Ltd., Montreal • Hewitt-Robins Internationale, Paris, France • Robins Conveyors (S. A.) Ltd., Johannesburg • **EXPORT DEPARTMENT:** New York City.

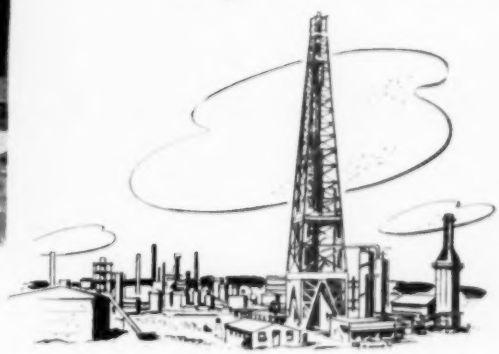
# TCC units powered by . . .



Driven by an Elliott 619-hp, 4100-rpm turbine, this single-stage centrifugal compressor has an inlet rating of 28,950 cfm at 14.4 psia and discharges at a pressure of 18.3 psia. It serves the TCC unit at Derby Oil Company, Wichita, Kansas.

This Elliott turbine-driven centrifugal compressor, operating at 4200 rpm, handles 24,850 inlet cfm of air at 100 F and 14 psia discharging at 3.75 psig. It provides air for the TCC unit at the plant of Vickers Petroleum Company, Potwin, Kansas.

# ELLIOTT Centrifugal Compressors



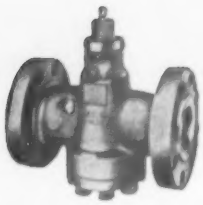
Thermofor Catalytic Cracking units, large and small, are served by Elliott turbine- or motor-driven single-stage centrifugal compressors. Providing the combustion air for catalyst regeneration and the air for lifting the catalyst to the top of the tower, the compressors are the heart of the plant, operating around the clock, sometimes years at a time without a shutdown. In this service the simplicity and reliability of Elliott units are popular with operating personnel.

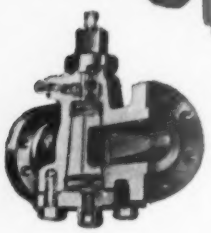
Consult your local Elliott representative for details, or write Elliott Company, Centrifugal Compressor Division, Jeannette, Pa.

**ELLIOTT Company**

P4-1

TURBINE-GENERATORS TURBINES MOTORS GENERATORS DEAERATING HEATERS EJECTORS CONDENSERS COMPRESSORS TURBOCHARGERS TUBE CLEANERS STRAINERS

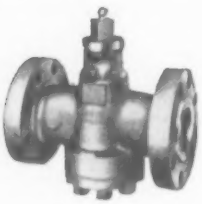
**THIS**  is a remarkable valve, as

 Lubricant goes in through

grooves in the plug and body

three things—it lubricates the seat

acts as a hydraulic jack to keep the

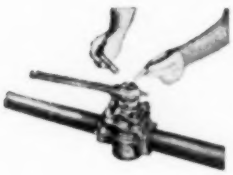
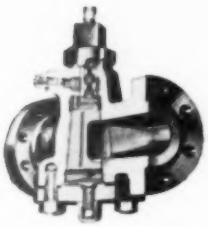
this valve  is safer, because it can

because lubricant stops seepage

because, by eliminating friction

most valves. What kind of valve is it?

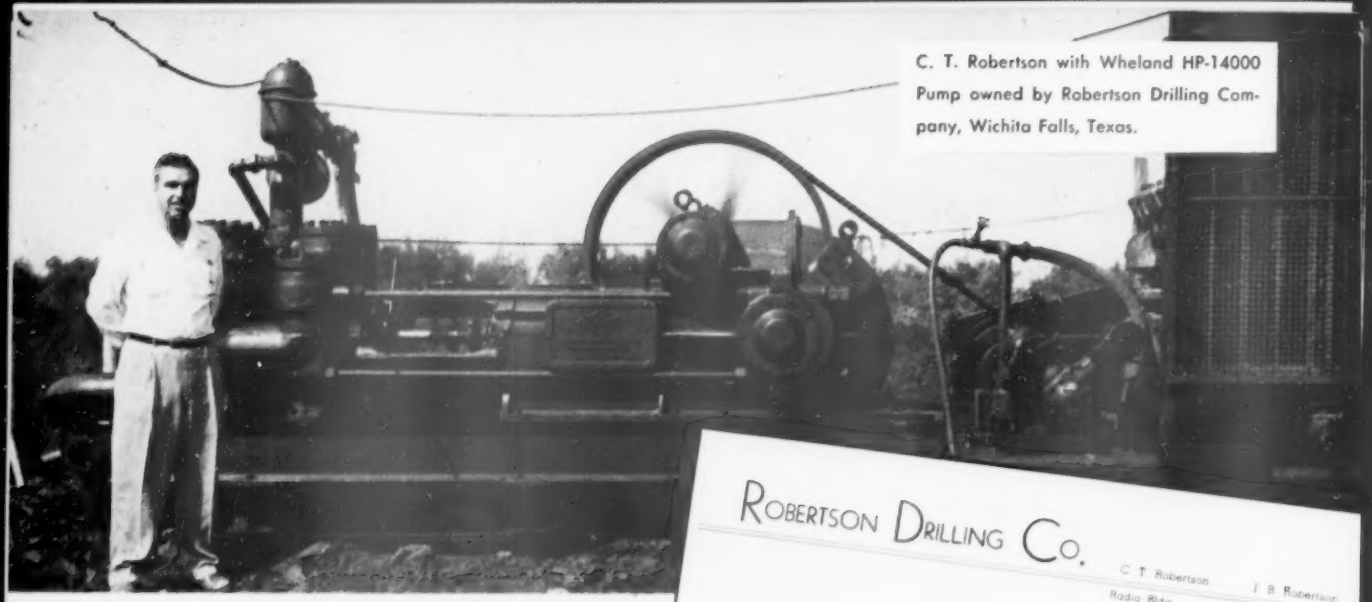
by **ROCKWELL** Manufacturing Company,

you will quickly see when you look inside the stem  and is forced through  . . In service, this lubricant does —it seals off the seating area . . . and it plug in position to turn easily. Consequently always be operated in an emergency, and, before it starts. It's also more economical and abrasion, lasts much longer than

Naturally, it's **ROCKWELL-NORDSTROM,**

Pittsburgh 8, Pennsylvania.

Canadian Licensee:
Peacock Brothers Limited



C. T. Robertson with Wheland HP-14000 Pump owned by Robertson Drilling Company, Wichita Falls, Texas.

"I have had approximately 20 drilling rigs in my life, with all makes of pumps, and **I WILL POSITIVELY STATE THAT YOUR NEW PUMP IS**

***BY FAR THE BEST"***

# WHELAND

## HP-14000 7½" x 14" DUPLEX SLUSH PUMP

## *350 Horsepower*

**nominal input at 60 RPM**

Discharge pressure with 7½" liners 838 PSI
Discharge pressure with 5½" liners 1627 PSI

***WRITE FOR DETAILED BULLETIN***

ROBERTSON DRILLING CO.

C. T. Robertson — J. B. Robertson
Radio Bldg. — Phone 5716
WICHITA FALLS, TEXAS

October 14, 1953

Mr. G. F. Street,
The Wheland Company,
Chattanooga, Tennessee.

Dear Mr. Street:

At the end of May, I purchased through Industrial Supply Company one of your new HP-11000 pumps. We have cut over 50,000 feet of hole in the North Texas area with your pump, and have never lost a minute of time. We have found that with your new pump and our new mud system, which consists of internal flush pipe, big hose and big kelly, with large bore drill collars, that we have been able to cut our drilling time on our 4,000 foot wells from approximately 12 to 13 days, to six or seven days. We have cut the number of bits used from 12 to 13, down to six or seven per well. Also, we have run jet bits and find that your pump has all the capacity that is needed to run jet bits.

I have had approximately 20 drilling rigs in my life, with all makes of pumps, and I will positively state that your new pump is by far the best, both from the service standpoint and it certainly could not be beat from the cost standpoint when you consider the capacity and pressures which it is capable of running under. You may feel free at any time to use my name as a reference on your pump.

Very truly yours,
ROBERTSON DRILLING COMPANY
BY: C. T. Robertson
C. T. Robertson

# WHELAND

THE WHELAND COMPANY, CHATTANOOGA, TENN., U. S. A.
*ROTARY DRILLING MACHINERY*

TRADE WHELAND MARK

**DRAWWORKS • SLUSH PUMPS**
**ROTARIES • CROWN BLOCKS**
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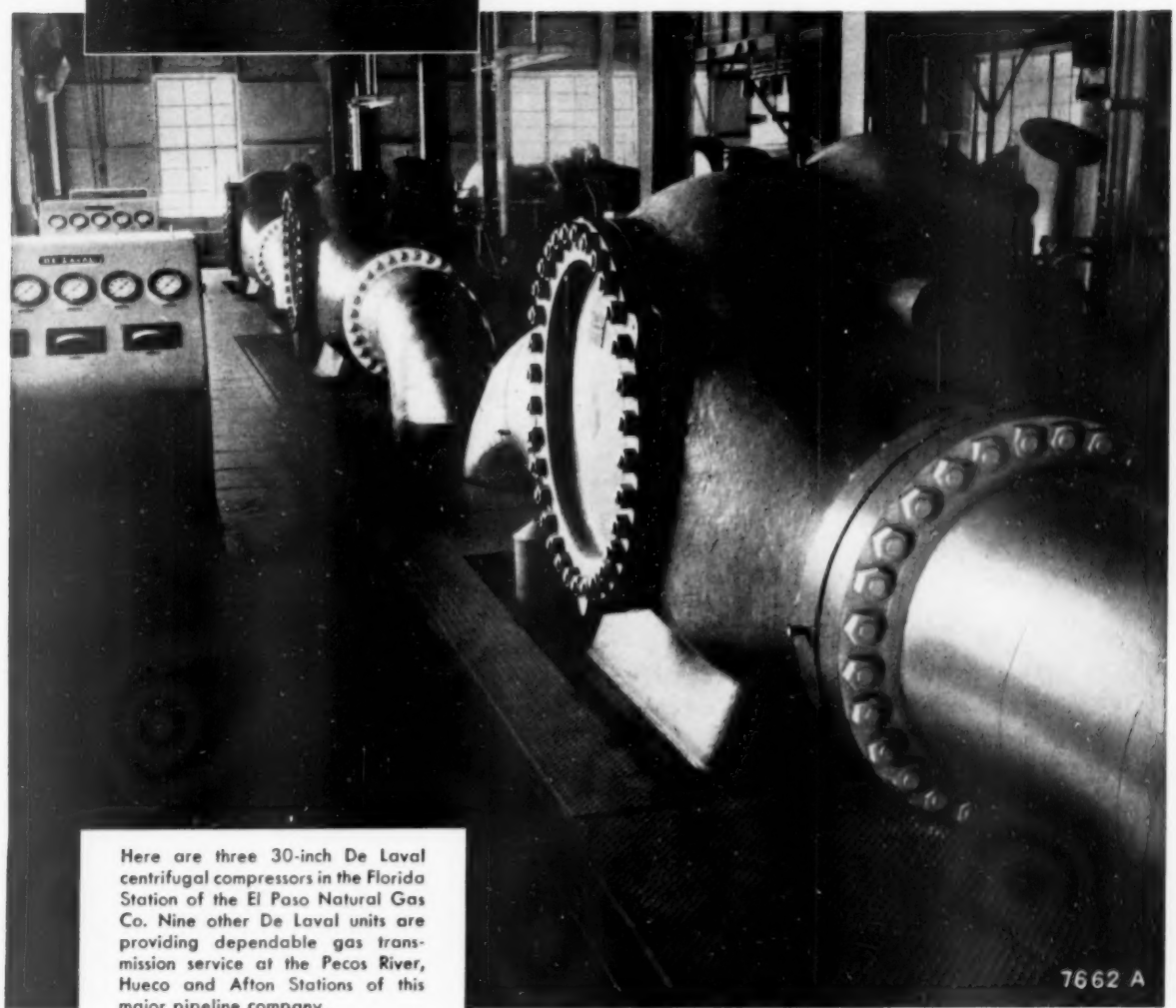
***DOMESTIC DISTRIBUTORS & THEIR HEADQUARTERS:*** Jones & Laughlin Steel Corp., Supply Division, Tulsa, Okla. • Houston Oil Field Material Co., Inc., Houston, Texas • Iverson Supply Co., Tulsa, Okla. • Lucey Products Corp., Tulsa, Okla. • Superior Iron Works & Supply Co., Inc., Shreveport, La. • Industrial Supply Co., Wichita Falls, Texas

***EXPORT DISTRIBUTOR:*** Lucey Export Corporation, 233 Broadway, New York 7, New York — Broad Street House, London, E. C. 2, England

# DE LAVAL CENTRIFUGAL COMPRESSORS *on the job at El Paso Natural Gas*




Here are three 30-inch De Laval centrifugal compressors in the Florida Station of the El Paso Natural Gas Co. Nine other De Laval units are providing dependable gas transmission service at the Pecos River, Hueco and Afton Stations of this major pipeline company.

De Laval centrifugal compressors offer many important engineering features. (1) They are designed to handle an increased ultimate flow, can be quickly converted to larger capacities by replacing the impeller, diaphragm and a few minor parts. (2) The high pressure shaft seal eliminates leakage, consumption of sealing oil is negligible. (3) There is only one moving part — the rotor — which has ample clearance. (4) Units are compact, require smaller foundations and smaller stations. (5) First costs and installation costs are low.

If you want detailed data on all the design advantages of De Laval centrifugal compressors, consult our engineers. They will be glad to give you the benefit of our wide experience on major pipelines.

**DE LAVAL** *Centrifugal Compressors*

DE LAVAL STEAM TURBINE COMPANY

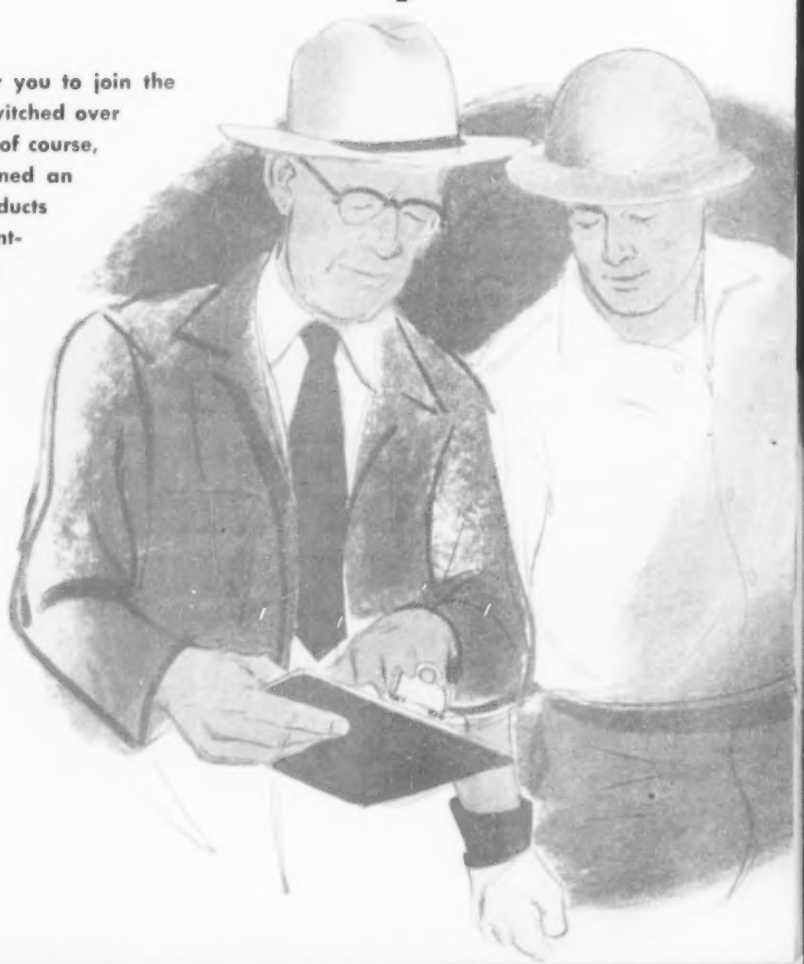
*810 Nottingham Way, Trenton 2, New Jersey*

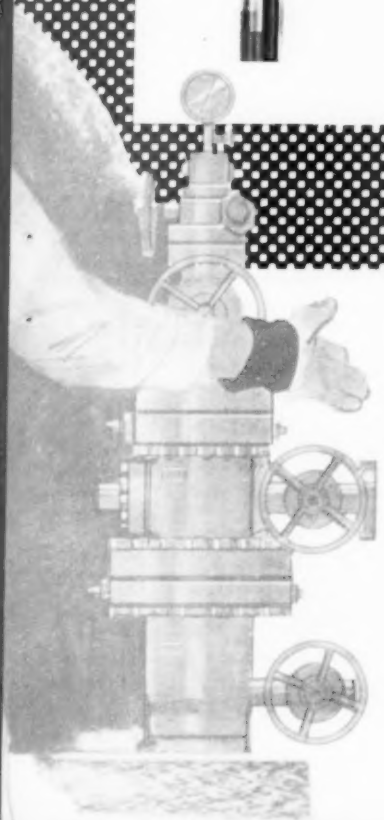
DL 220

# ECONOMY
# SERVICE
# SAFETY

## It's the extra value that makes O-C-T stand out

There are many good reasons for you to join the growing list of oil operators who have switched over to O-C-T Products. The best reason of all, of course, is the fact that O-C-T Products have earned an industry-wide reputation as the finest products money can buy. This record-for-consistent-performance has been marked up in wells of all depths and pressures. Isn't it logical then that you should learn about the added strength, safety, convenience and flexibility provided by dependable O-C-T products? Let us furnish complete information and quotations on your next well. No obligation. Write today or talk to your O-C-T Representative.

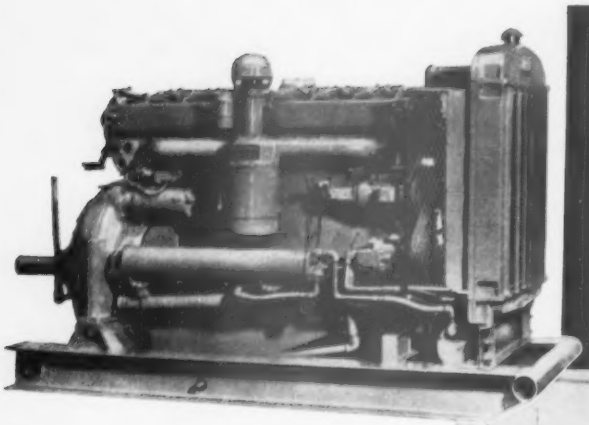




**Oil Center Tool Co.**

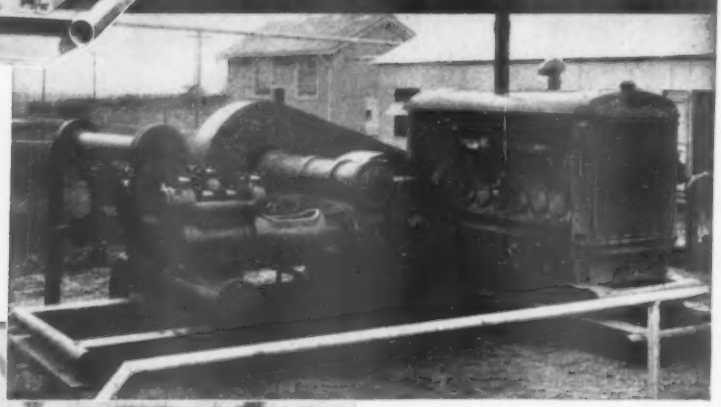
P. O. BOX 3091, HOUSTON, TEXAS

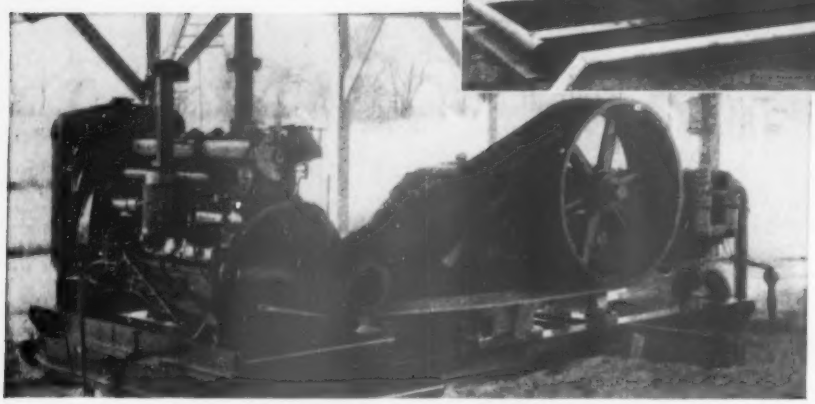
Export Representatives: Sterling Areas — Le Grand, Sutcliff & Gell, Ltd., Rochester, Kent, England. Address Export Inquiries for All Other Countries to P. O. Box 3091, Houston, Texas.



# MURPHY DIESELS

**rugged, reliable, economical to operate . . .**





## . . . furnish dependable power for field pumps

Power for pipeline pumping must be rugged, reliable, reasonable in cost. Murphy Diesels provide just such power. Advanced engineering features, including distortionless pistons, interlocking connecting rods, extra heavy crankshafts, dual overhead camshafts and flywheel end cam drive add years to trouble free service. Unit fuel injection and the "true" diesel combustion system assure rock bottom fuel costs.

Put them all together and you can easily see why Murphy Diesels give rugged, reliable, low cost service. Murphy Diesel's high standards of performance and economy are explained in "10 REASONS why your next engine should be a MURPHY". Get a copy from your Murphy dealer or write direct.

**MURPHY DIESEL COMPANY** 5305 W. Burnham St., Milwaukee 14, Wisconsin

**FACTORY BRANCH Sales, Parts and Service—113-116 So. Elwood Ave., Tulsa, Okla.**

**Murphy Diesel engines and power units, 90 to 260 H.P.; dual-fuel engines, 135 to 215 H.P.; generator sets, 60 to 154 K.W.**

275

MURPHY DIESEL

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Constructors Equipment Company
Edmonton, Alberta, Canada
Northern Engine & Equipment Co., Ltd.
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J. E. Ingram Equipment Co.
Great Bend, Kansas
Manufacturers Dist. Co.
Great Falls, Montana
Hall-Perry Machinery Company
Houston, Texas
Houston Engine & Pump Co., Inc.
Odessa, Texas: Conley-Lott-Nichols Machinery Co.
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Industrial Engine Service
Lubbock, Texas
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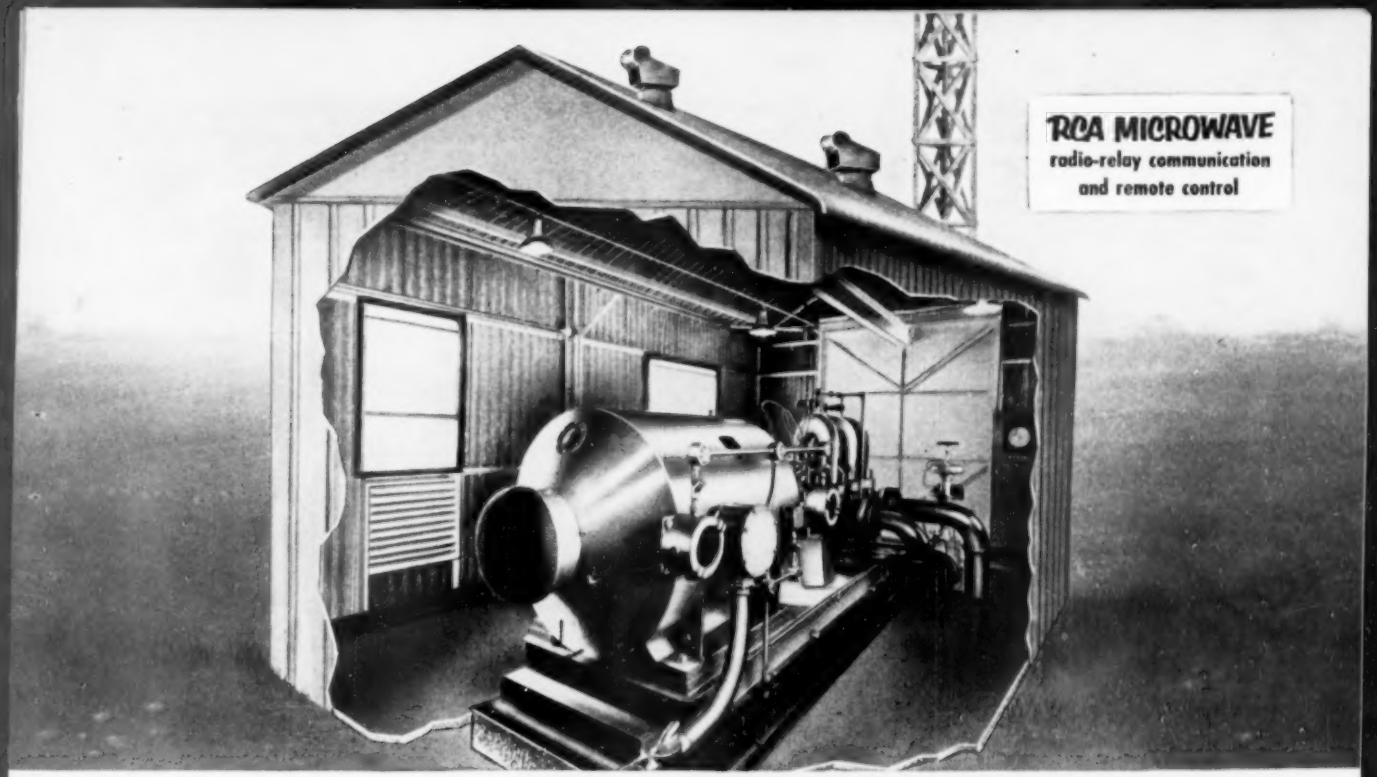
Bakersfield, California
Glenn Rose Engine Service
Longview, Texas
Nichols Machinery Co.




**Cutaway of Sunray remote-controlled station pump room.** Pneumatically operated pump-discharge motor valve and controller are in background

# What makes SUNRAY's unattended booster stations *tick?*

Sunray Oil Corporation's 960-mc RCA Microwave system makes them "tick" by remote control. Three unattended booster pump stations have stepped up the capacity of Sunray's 97-mile refinery-facilities pipeline between Sunray Village (Duncan) and Allen, Oklahoma, by as much as 25%—*without requiring bigger pipe.*

RCA "dish" antennas "beam" highly concentrated radio signals from one relay station to the next . . . carry impulses which start, stop, and control "boosters" as required. Electrically driven valves function automatically at each booster station. Should equipment fail, station shuts down automatically . . . pumps stop . . . suction and discharge valves close. And "boosters" can be operated locally if desired.

### Microwave for T/M channels, too

Telemetering equipment at Sunray's two regular stations records performance of "boosters" from data received via Microwave. It charts a continuous record of suction and discharge pressures—plus kilowatt-hours of power being used—in front of the operator. Microwave radio impulses cause signal lights to indicate when booster station equipment fails, tower lights go out, or emergency generators go into operation.

To start a remote-controlled booster station, attendant at control station checks discharge pressure at his console, adjusts pumping rate to get optimum by-pass pressure for starting, then presses a *start* button. This closes a relay at the "booster." Relay causes a suction valve in station manifold to open and permits fluid to enter pumping unit. When valve is full open, it activates a switch which starts pump motor. When pump reaches normal operating speed, manifold discharge valve opens, and station is on the line.

### Shutting down "boosters"

When operator pushes *stop* button at his console, this immediately reverses starting procedure, and isolates the "booster" from the line, in stand-by status.

In addition to remote control and supervisory functions, RCA Microwave provides as many voice and teletype channels as needed—and does it with a minimum of frequency space. It employs readily available tubes and familiar circuits which are easy to service. It can be interconnected with telephone lines and switchboards.

### RCA service available

If desired, RCA supervises survey, construction and installation—offers a complete single-source, single-responsibility service. *And remember,* only RCA can provide the nationwide service facilities of the RCA Service Company.

**Operator at control console** at regular pump station also controls remote stations. Telemeter charts provide continuous record of both local and remote station operation over 24-hour period

**Remote-station control building** contains radio cabinet (right); cabinet for relays, switches and starting equipment (center); controls for local operation (left). Stand-by generator is in background

**For more information, mail coupon below.**

RCA **RADIO CORPORATION of AMERICA**
COMMUNICATIONS EQUIPMENT CAMDEN, N. J.

Dept. CD89, Building 15-1.

Without obligation on my part, please send me your *free* booklet on:

- ☐ A Booster Station Microwave System
- ☐ Pushbutton Operation of Boosters

Name_____

Title_____

Company_____

City_____ Zone____ State_____

☐ Have an RCA representative get in touch with me.

# CATFORMING *means*

# SIMPLICITY

## for high octanes and high yields at low cost

Simplicity is the keystone of Catforming. Why? Because simplicity takes the high cost out of high octanes and high yields.

Simplicity speeds construction of Atlantic Catforming units—saving you money and time.

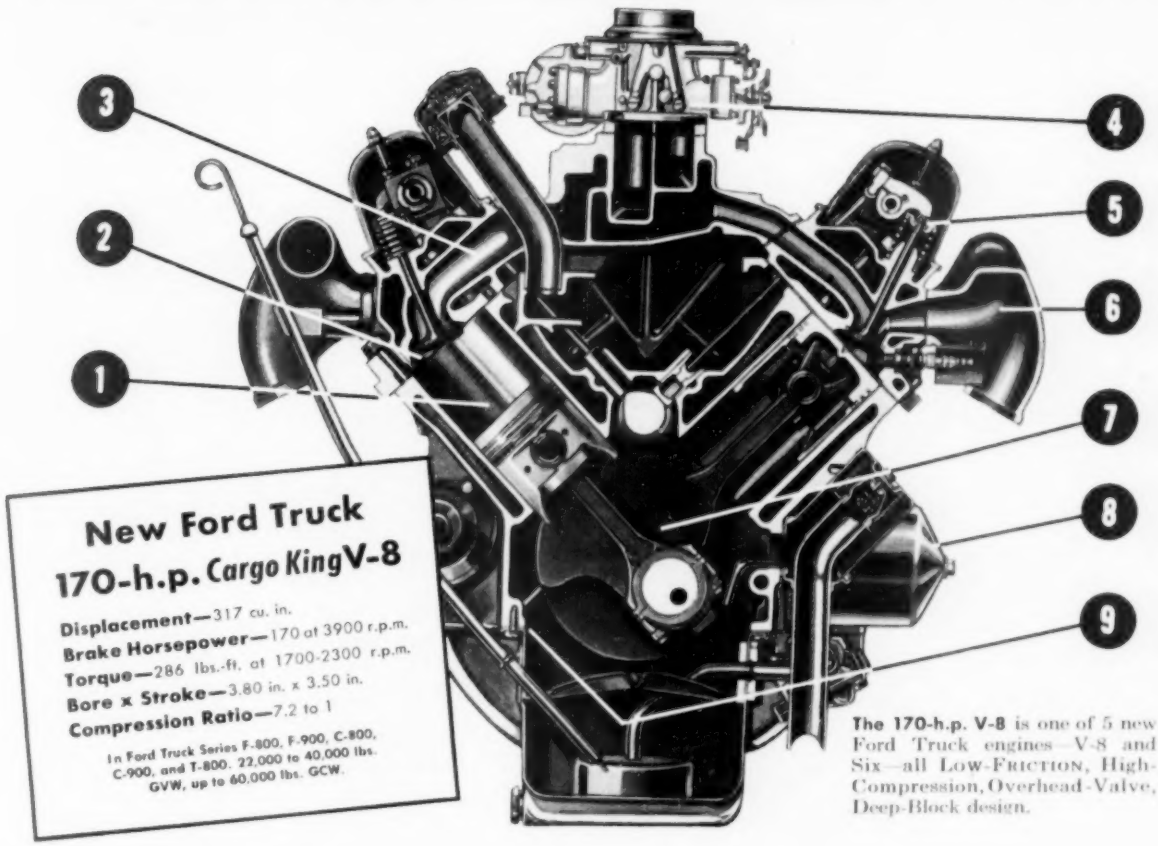
Simplicity makes operation of these units easy—saving you money on operating costs and manpower as well.

Simplicity means efficiency — Catforming cuts out intermediate steps in processing feed stocks, gives you high octane gasoline ready for immediate blending—and distribution.

Simplicity goes all the way with Catforming, including the licensing agreement—you'll find it well worth looking into. Remember, the performance of Catforming units has been proved in highly successful commercial operations in many areas. Write, wire or phone for detailed information — ask for our brochure, "CATFORMING." The Atlantic Refining Company, Research and Development Dept., P. O. Box 8138, Philadelphia 1, Pa.

ATLANTIC *It's the Catalyst that counts*

**ANOTHER WAY YOU SAVE WITH FORD *TRIPLE ECONOMY***




**New Ford Truck**
**170-h.p. *Cargo King* V-8**

**Displacement**—317 cu. in.
**Brake Horsepower**—170 at 3900 r.p.m.
**Torque**—286 lbs.-ft. at 1700-2300 r.p.m.
**Bore x Stroke**—3.80 in. x 3.50 in.
**Compression Ratio**—7.2 to 1

In Ford Truck Series F-800, F-900, C-800, C-900, and T-800. 22,000 to 40,000 lbs. GVW, up to 60,000 lbs. GCW.

**The 170-h.p. V-8** is one of 5 new Ford Truck engines—V-8 and Six—all LOW-FRICTION, High-Compression, Overhead-Valve, Deep-Block design.

# Up to 41% more power per cubic inch
## —than other truck engines in its class!

***Here's why the Cargo King V-8 gives you power with economy...the No. 1 saving in Ford Triple Economy!***

**1. Short-Stroke power**—In the new *Cargo King* V-8, short-stroke design reduces piston travel as much as 34%. This cuts wear, repair costs, and internal friction losses . . . releases more "useful" power, saves gas. Cylinder and combustion chamber design permits larger intake and exhaust valves for more efficient fuel use, less dissipation of heat to cooling system. More energy per pound of fuel is converted into *usable*, load-moving power.

**2. High-Turbulence combustion chambers** are wedge-shaped to create high turbulence, give more efficient fuel-air combustion without pre-ignition.

**3. Short-Reach intake manifold** is two manifolds in one single casting. Carburetor mounted directly to manifold allows short passages, delivers uniform fuel charge to all cylinders for greatest power, easy starting.

**4. Exclusive de-popper valve** on dual concentric carburetor eliminates backfiring when decelerating.

**5. Free-turn valves** rotate freely for self-cleaning action, better seating, minimize valve warpage, wear and sticking.

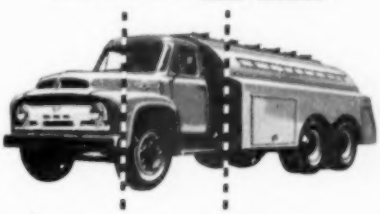
**6. Ram's Horn exhaust manifold** improves breathing efficiency of new *Cargo King* by scavenging exhaust gases faster.

**7. Precision-molded alloy iron crankshaft** is a Ford exclusive. Permits more rigidity in design, with three times better self-damping.

**8. Full-Flow oil filter** cleans *all* oil before it reaches bearing surfaces, reduces cylinder wall, piston ring and bearing wear. Replaceable cartridge type.

**9. Deep-skirt crankcase** extends 2¼" below center of crankshaft for greater rigidity to resist distortion, provides maintenance of bearing alignment for long life and smooth engine performance.

***SAVE WITH ALL THREE***



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3. *New Money-Saving Capacities*

**FORD *TRIPLE ECONOMY* TRUCKS**
***MORE TRUCK FOR YOUR MONEY!***

**For complete information, see your Ford Dealer today, or write: FORD Division, FORD MOTOR CO., Dept. T-20, Box 658, Dearborn, Michigan.**

# how long-run advantages work for you...

When you power beam pumps, circulation systems, Triplex, lease or field injection pumps with Minneapolis-Moline Oilfield Engines, you save service hours never believed possible . . . actually change service dates from days to many months.

Equipped with exclusive long-run advantages such as the MM water-jacketed base pan which maintains oil at a determined constant temperature regardless of weather or load conditions, massive MM parts and larger bearing surfaces, vacuum crankcase ventilation, water by-pass cooling . . . built-in oil-flow controllers . . . sealed pressure cooling . . . all backed by MM's strict quality control . . . you get *lowest cost* production power per h.p. hour.

For complete facts and specifications, contact your Minneapolis-Moline oilfield distributor. Let him show you why you're *ahead* with MM power.

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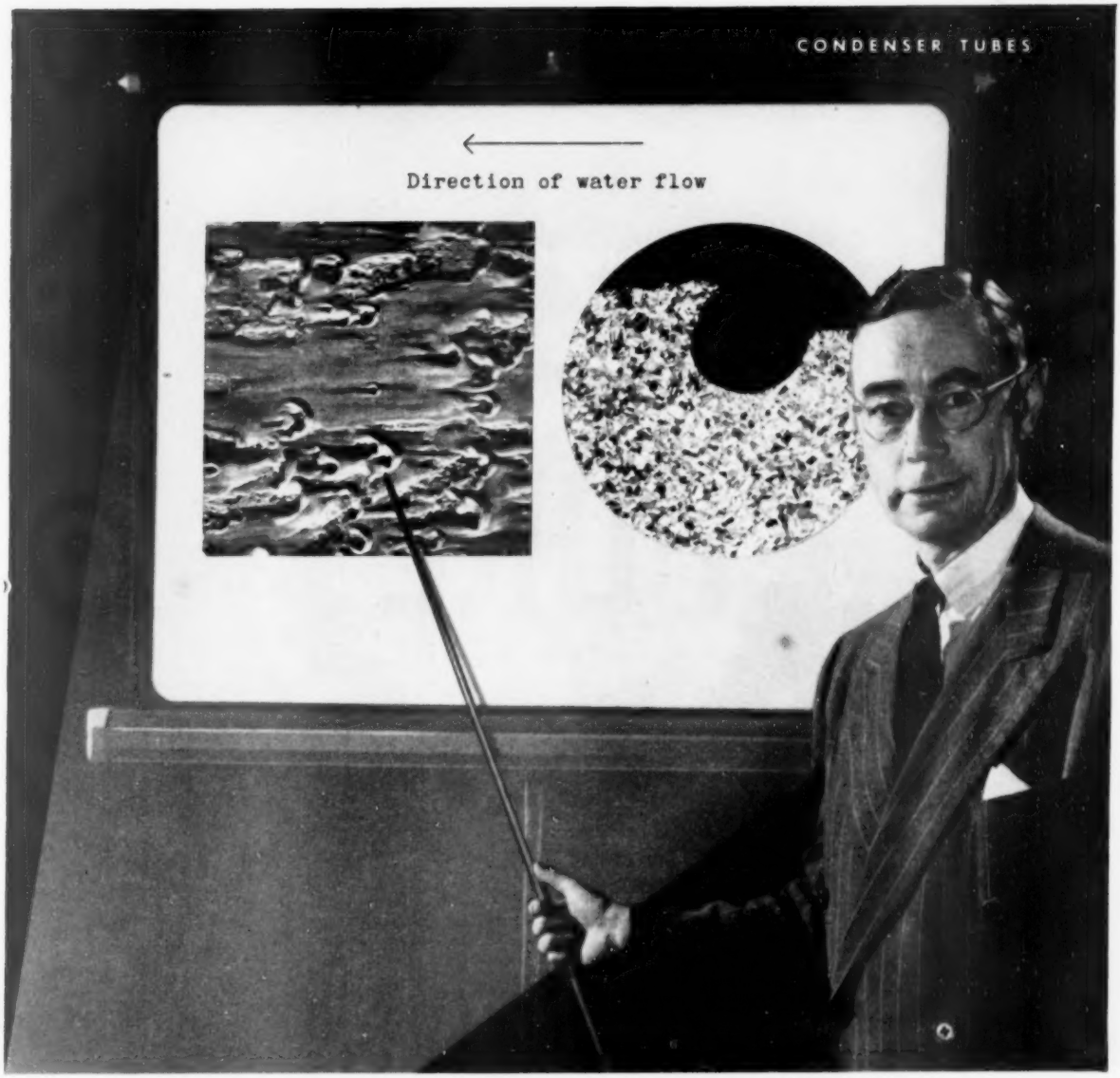


Illustration at left shows impingement corrosion of an Admiralty tube by high velocity sea water containing air bubbles. At right, longitudinal section through part of horseshoe-shaped pit is shown.

# AIR BUBBLES: what causes them, how they affect condenser tubes

Before corrosion can occur, oxygen from the air dissolved in cooling waters must be present. But normally its presence doesn't cause *rapid* corrosion of condenser tubes.

What can cause rapid corrosion is air in the form of bubbles where turbulent flow is present. Whirlpools in the intake tunnel, leaky packing glands on pumps and at projections in injection pipes or water boxes may produce air bubbles of harmful size. Any condition that will produce a negative pressure at some point along a tube, such as a long outlet leg from a condenser, can cause air bubbles. Local pitting may then occur rapidly.

Air bubbles are only one factor affecting tube life. Publication B-2, "Anaconda Tubes and Plates for Condensers and Heat Exchangers," discusses *all* the important operational factors, and gives much other useful information. And, of course, our Technical Department stands ready to assist you in the selection of tube alloys from our extensive line. *The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.*

54106

**ANACONDA®**

**Tubes and Plates for Condensers and Heat Exchangers**

*Arsenical Admiralty-439; Ambraloy-927*; Cupro Nickel, 30%-702; and other copper alloys.*
*U. S. Patent No. 2,003,685 (Orig.)

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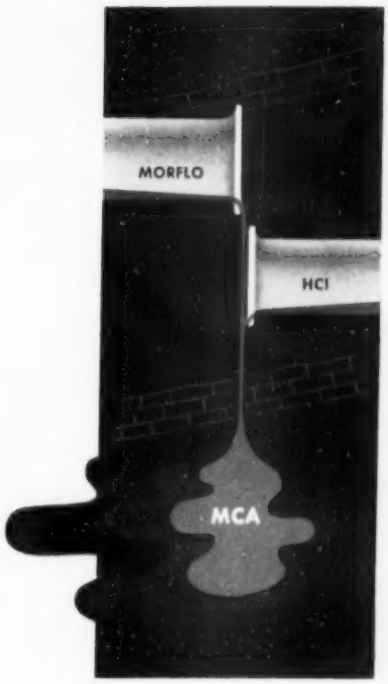
# OPERATORS CLEAN UP * WITH MAGIC CHEMICALS

## HALLIBURTON'S *DOUBLE ACTION* MCA




When free flow is dammed by water-swollen bentonite or oil-water emulsions or mud and water blocks —only double action MCA is designed for the job. Halliburton's Mud Cleanout Agent provides a new answer to these old problems by combining the powers of hydrochloric acid *and* Morflo, a highly active surfactant and emulsion breaker. It's this combination of hydrochloric and organic sulfonic acids — this double action — that puts new life in wells.

Here's how MCA does it. When particles of water-swollen bentonite choke off flow, MCA actually shrinks the particles and frees both adsorbed and nuclear water. MCA permanently changes bentonite into non-expanding particles that will not rehydrate even when flooded with fresh water. Next, working as a disperser, MCA cracks mud filter cake and penetrates deep into the formation to attack clogging muds. A fluid mud mixture is created which is easily removed. Then the emulsion breaking action of MCA combines with a vital lowering of surface tension to clear pay zones and restore normal permeability.

Strictly mechanical processes can't do the job. And experience showed that regular acids were doing only half the job. But results prove that double action MCA consistently removes aqueous *and* bentonitic blocks in both sand and limestone formations. Learn how MCA can help increase your production by clearing plugged pay zones. You'll find MCA is easy to use and economical, too. Just call your local or district Halliburton office. Or contact Halliburton Oil Well Cementing Company, Duncan, Oklahoma.

*

| FIELD | BOPD | | REMARKS |
|---|---|---|---|
| | Before MCA | After MCA | |
| East Bartlett, Texas | 60 | 168 | 20 feet of pay zone treated |
| Carenton, Louisiana | 0 | 100 | Usual treatments unsuccessful |
| Cree-Sykes, Texas | trace | 140 | 48 feet of pay zone treated |
| Southern Alberta | 0 | 50 | Previous production — 20 bbl. water |
| Harvey, Texas | 0 | 165 | At 8000-8002 feet |
| Claytonville, Texas | 360 | 1200 | Recovered 300 bbl. of lost mud |

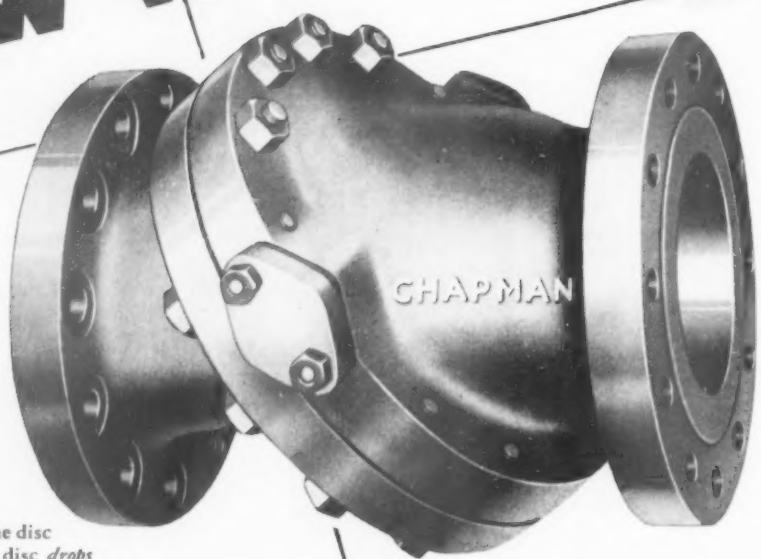
**HALLIBURTON**

**CHEMICAL SERVICES**

PERPETUAL PROGRESS IN PRODUCTION IMPROVEMENT TECHNIQUES

# *Only* Chapman's *Tilting-Disc* Check Valves Give You...

# NO SLAMMING
# LOW HEAD LOSS
# LOW WEAR




Here's the check valve that stays open with minimum flow resistance, closes fast without slamming, closes tight without sliding or scraping wear.

## Cushioned Closing

Pressure against the upper part of the disc cushions it as it closes. Then the disc *drops tight* to its beveled seat after the valve has swung closed. Both actions are fast, but they are fluid-cushioned. Seating is quiet in all but unusual piping arrangements.

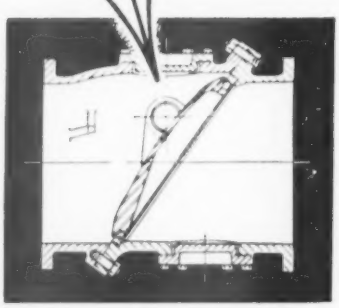
## Low Flow Resistance

The streamline design of the valve body and disc eliminate turbulence and cut flow resistance. The fluid holds the disc tightly against its stops, without flutter. The body is larger around the disc, so the net valve area is at least as much as the pipe area.

## Minimum Wearing Action

Because the disc *drops* tight, it doesn't slide against the seat. The wear on hinge pins is small because the disc doesn't flutter. Unusually husky construction in every detail means long life under the toughest conditions for Chapman's Tilting Disc Check Valve.

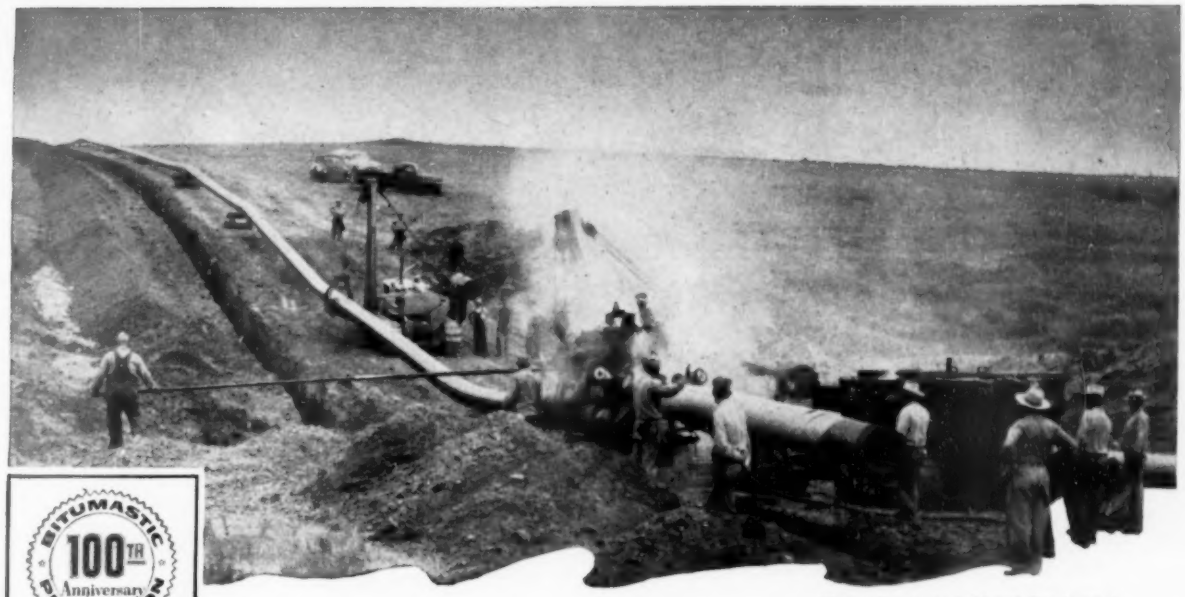
Full engineering and construction data are in Chapman's Catalog #30. Write for it now.



**Here's Why CHAPMAN Tilting Disc Check Valves *Keep Quiet* All Their Lives**

This specially designed "airfoil" disc balances perfectly in open position . . . then drops easily to closed position (cushioned by the flow). No jarring or slamming, in usual pipe-layouts. Write for bulletin.

**The CHAPMAN VALVE**
**Manufacturing Company**
INDIAN ORCHARD, MASSACHUSETTS



Photo—Courtesy of Oil and Gas Journal

Coating and wrapping machine kicking off on section of primed pipe.

BITUMASTIC 100TH Anniversary PROTECTION 1854 1954

# Bitumastic® Enamel

## *plays an important role in protecting the Platte Pipe Line against corrosion*

• The Platte pipe line, completed in 1952, is one of the longest single carriers of crude oil in this country. More than 1,000 miles long, this line starts near Worland, Wyoming, and ends near Wood River, Illinois. It is tapping the rich oil reserves of the Rocky Mountain area in excess of 100,000 barrels a day.

This huge steel pipe line is protected by Bitumastic® Enamel against corrosive soils in Wyoming, down through Nebraska, across the Kansas border. Many oil and gas pipe lines, protected by Bitumastic Enamel 20 and 30 years ago, are still in excellent condition today.

Here are some of the properties that make Bitumastic Enamel the best barrier against corrosion: 1) High resistance to water; 2) High electrical resistance; 3) High resistance to soil chemicals; 4) Stability under soil stress; 5) Lasting ductility.

Whether you're interested in protecting large or small lines, oil, gas or water lines, it will pay you to specify Bitumastic Enamel. Get in touch with one of the offices listed below. Our representative will be glad to tell you all about Bitumastic Enamel.

KOPPERS BITUMASTIC ENAMELS

REG U S PAT OFF

**KOPPERS COMPANY, INC., Tar Products Division, Dept. 403-T, Pittsburgh 19, Pennsylvania**

DISTRICT OFFICES: BOSTON, CHICAGO, LOS ANGELES, NEW YORK, PITTSBURGH, AND WOODWARD, ALA.

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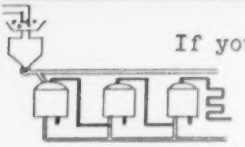
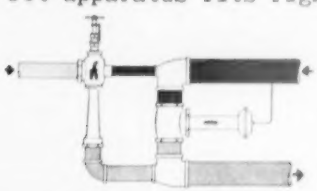
ENGINEERING News

JET APPARATUS • HEAT TRANSFER EQUIPMENT • STRAINERS • CONDENSERS AND VACUUM PUMPS • OIL BURNING EQUIPMENT •
RETROMETERS • FLOW INDICATORS • RADIATOR TUBES • VALVES • SPRAY NOZZLES AND ATOMIZERS • GEAR PUMPS • DESUPERHEATERS



If you plan, supervise, or maintain continuous process operations, consider the suitability of Jet Apparatus for such operations. For jet apparatus, though it requires skill in designing, is outstandingly simple — has three principal parts which include: a converging nozzle for liquid actuated jets or an expanding nozzle for gas actuated jets , a tail or diffuser , and a body to hold these parts in their proper relative positions.

Jet apparatus fits right into the pipeline. The actuating medium can be either liquid or gas. Small, in relation to the work they do, easy to install and maintain, one of many SK Jet Types can be used to:



**1 MEASURE and MIX**
*In Continuous Operation*

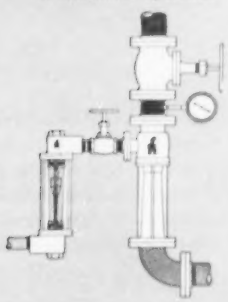
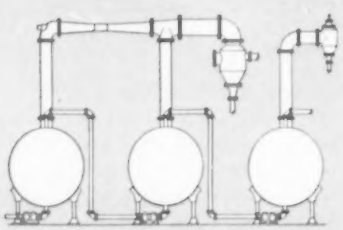


**FIG. 242-B. SK Jet Eductor and SK Rotameter are used to mix liquids in desired proportion.**

**2 COOL and CONCENTRATE**
*In Continuous Application*



**SK High Vac apparatus used to cool sugar syrups after processing.**

**3 PUMP and HEAT**
*In Continuous Process*

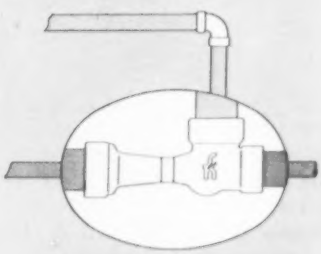


**FIG. 217. SK Steam Jet Syphon mixes cold water with steam to discharge hot water.**

and (4) to perform thousands of similar jobs in plants all over the country. For types of Jet Apparatus offered by SK and a summary of applications, write for Bulletin SK-1.

*Representatives in Principal Cities*

**SCHUTTE and KOERTING Company**
23 STATE ROAD • CORNWELLS HEIGHTS • BUCKS COUNTY, PA.

# They Say—

### Federal Control Threat to Gas

"Many of us have had hopes that by this time the threat of federal manipulation of gas prices received by independent producers would have been removed. The issue is still before us. Even with a Federal Power Commission that has shown every indication of being fair and understanding, the need for a clarification of the Natural Gas Act is still urgent.

"We contended when we had an antagonistic commission, and we contend now, that our rights can only be permanently protected by law and not by a change in men.

"The present commission has disavowed any power to fix the price of natural gas sold in the field, but the recent Appellate Court decision in the Phillips case leaves that threat hanging over us.

"Under present interpretations of the law, every gas-using group in America is given the machinery for taking Texas gas at their price. If the power of the federal Government can be used in this way, then our position as independent producers is a thing of the past. We will be, in effect, treated as utilities but without the privileges enjoyed by utilities."

*Harry W. Bass, president, Texas Mid-Continent Oil & Gas Association, Dallas, in an address before association members.*

### Federal Gas Price Control Hit

"There is at present one unresolved question upon the wise solution of which the future of the entire (gas) industry may depend. This is, of course, whether the producers of gas are to be subject to regulation by the Federal Power Commission as to the prices they receive for the gas they produce.

"It is my opinion that such regulation would be extremely difficult and expensive to achieve and disadvantageous in end result and that our present system should continue.

"State regulatory bodies, particularly the Texas Railroad Commission, have on the whole done a statesmanlike job with respect to regulating both gas and oil production. It is evident that the prime need for the entire gas industry is for not only continued but increased exploration and developmental activity.

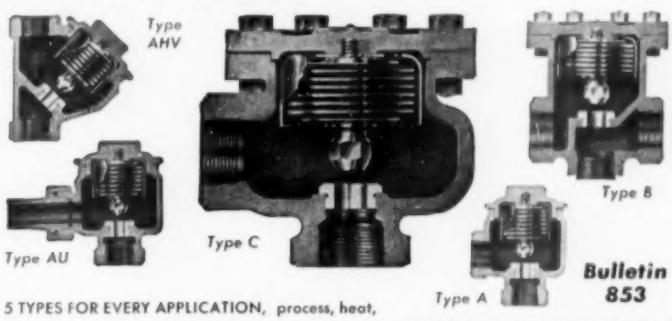
"Anything that puts a restraint on such activity, will not only adversely af-


In This Plant Nicholson Traps

SAVED 10% IN STEAM COSTS

Chief Engineer H.F.D. stated, after Nicholsons replaced mechanical traps in his plant: "Saving in steam waste cut our fuel cost at least 10%. Yet application temperatures were up 30°-40°. And relief of all air binding effected faster warm-up."

Operate on lowest temperature differential; 2 to 6 times average drainage capacity; maximum air venting. For other advanced Nicholson features send for Bulletin 853.




5 TYPES FOR EVERY APPLICATION, process, heat, power. Sizes ¼" to 2"; pressures to 250 lbs.

Bulletin 853

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NEW P&H COLOR SOUND FILM

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Plan a review of this educational and entertaining color sound-slide film. Ask your P&H dealer about it . . . or write us for details.

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HARNISCHFEGER CORPORATION CRYSTAL LAKE, ILLINOIS

the P&H line

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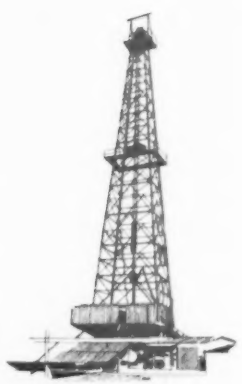
# SIMULTANEOUS R/A LOGGING

Welex SIMULTANEOUS Gamma Ray and Neutron Curves drastically reduce your down time. Licensed by WSI, Welex Radioactivity Logging equipment is NEW, FAST, and ACCURATE. Casing collars are correlated to each formation, positively locating your perforating zones. The result is clear definitions of repeatable curves adaptable to quantitative interpretation.



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fect the entire gas industry but will, within a short period, affect the available supply of gas to consumers and will, in my opinion, eventually substantially increase the amount which consumers must pay."

*Stuart F. Silloway, vice president for finance, Mutual Life Insurance Co. of New York, in an address before the workshop conference of Independent Natural Gas Association of America at New Orleans.*

**Products Taxation Vital Issue**

"The taxation on petroleum products is a very vital issue of double meaning to each and every one of us in the petroleum industry. It has an indirect bearing upon us through our customers and a very direct bearing upon us through the use of our own products on the highways.

"In competition we are vitally affected by the amount of taxes on our products—as to whether our individual customers spread their own budgets more or less toward the purchase of petroleum products. We are competitors against all other businesses as well as each other for the consumer's dollar.

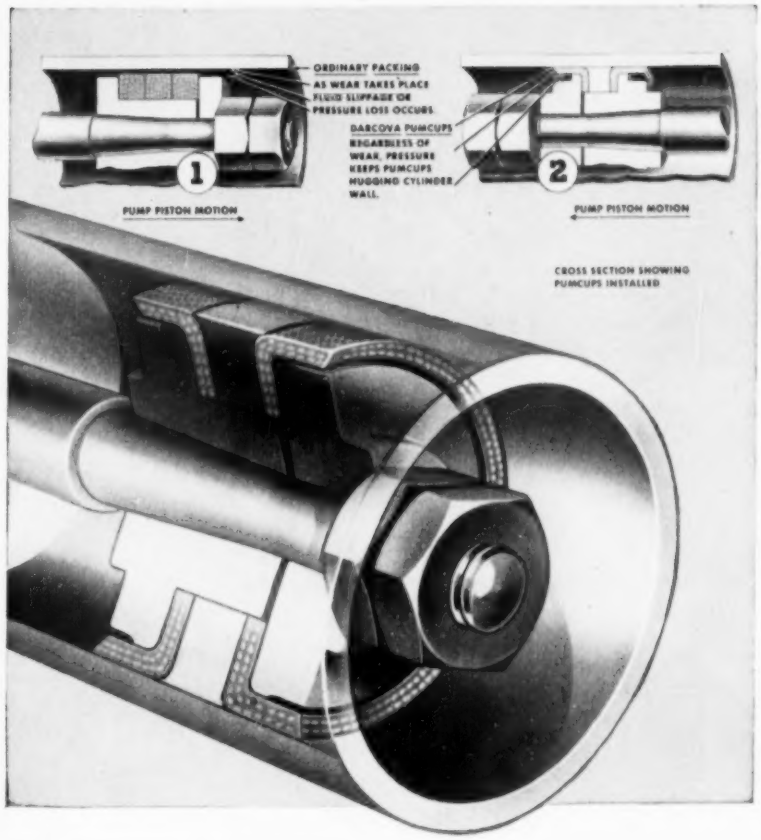
"Legislators in various states have taken the tax situation on gasoline for granted, in that they have failed to realize the costly machinery necessary in petroleum companies to effect the collection of taxes for the states with so little effort expended by the state."

*Robert L. Milligan, executive vice president, Pure Oil Co., before the 1954 Ohio Petroleum Marketers Association convention.*

**Wanted: New Major Discoveries**

"Although supplies of crude oil currently are adequate, the long-range trend is for a constantly increasing demand in the United States. Based on results of exploratory drilling in the United States in recent years, the industry will be hard pressed to discover enough new supplies of crude oil to maintain an adequate ratio between total reserves and this growing demand. No new areas of great promise were found in this country last year even though more exploratory wells were drilled than in any previous year.

"The industry continues to produce largely its lower cost reserves, discovered years ago, which are steadily being depleted. In the face of rising costs of finding and producing oil, there is a serious question as to how long the industry can continue to fulfill increasing needs for oil at today's prices. Present crude oil prices are firm; however, continued increases in the current high inventories of gasoline



ORDINARY PACKING AS WEAR TAKES PLACE FLUID SLIPPAGE OR PRESSURE LOSS OCCURS
DARCOVA PUMCUPS REGARDLESS OF WEAR, PRESSURE KEEPS PUMCUPS HUGGING CYLINDER WALL
1
2
PUMP PISTON MOTION
PUMP PISTON MOTION
CROSS SECTION SHOWING PUMCUPS INSTALLED

# DARCOVA PUMCUPS mean EFFICIENCY to cost-minded engineers!

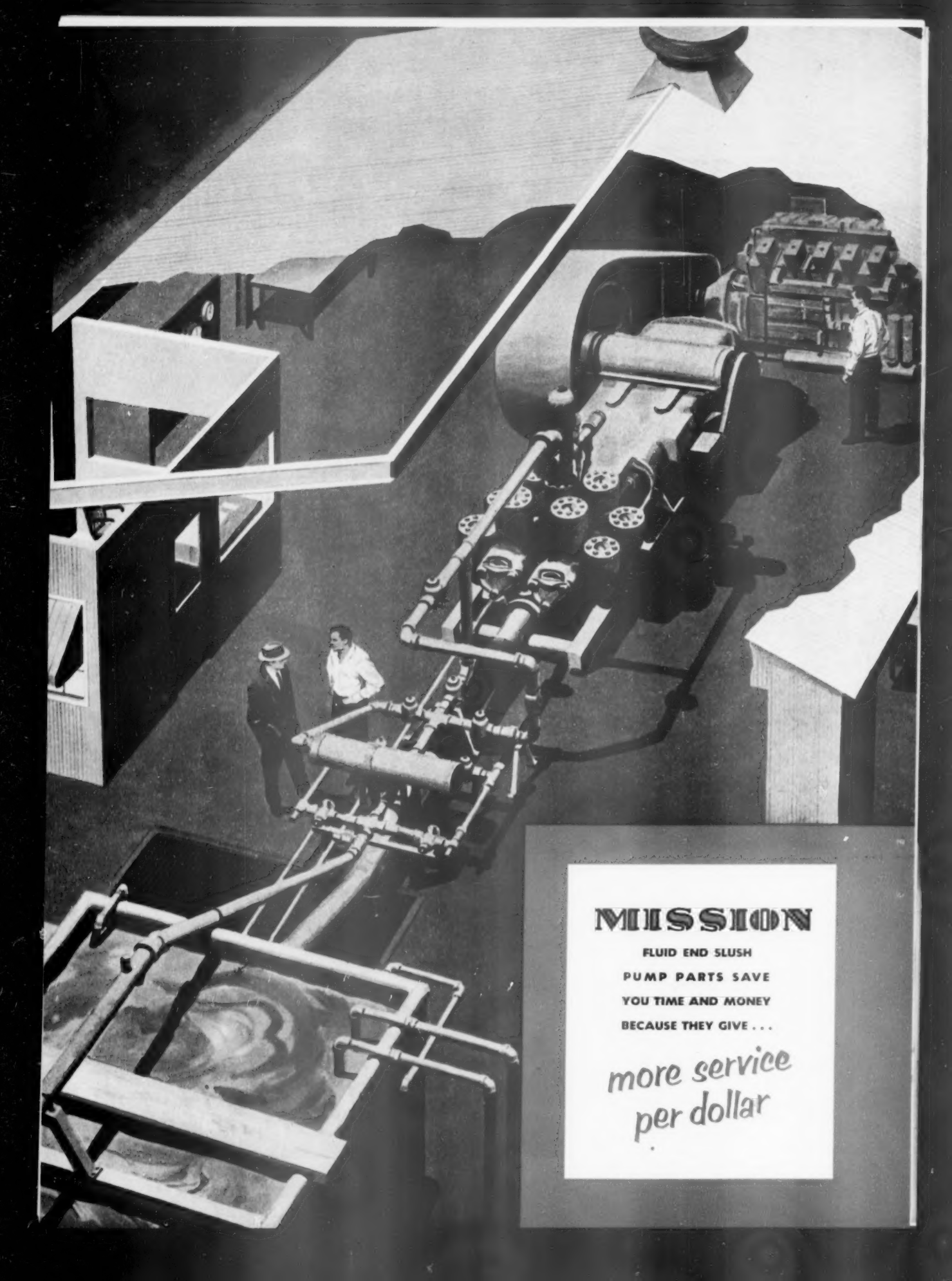
*IN air and hydraulic cylinders and reciprocating pumps* Darcova Pumcups actually retain full efficiency *throughout* their life span . . . and they outlast most other packings at least 3 to 1!

Special texture engineering plus the Darcova Pumcup principle makes it possible for Pumcups to hold their peak volumetric efficiency. Moreover, Pumcups permit equipment to be operated at reduced speeds, save power, prolong equipment life and eliminate the need for frequent replacement shutdowns.

For less maintenance and lower operating costs find out more about Darcova Pumcups. Write for Bulletin No. 4502 on Pumcups for air or hydraulic mechanisms, Bulletin No. 4401 on Pumcups for reciprocating pumps.

**DARLING VALVE & MANUFACTURING CO.**
**Williamsport 1, Pa.**

DARCOVA
THE ORIGINAL COMPOSITION CUP
PUMCUPS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FLUID END SLUSH
PUMP PARTS SAVE
YOU TIME AND MONEY
BECAUSE THEY GIVE . . .
more service
per dollar

# *Why these Mission Pump Parts never get a day off*

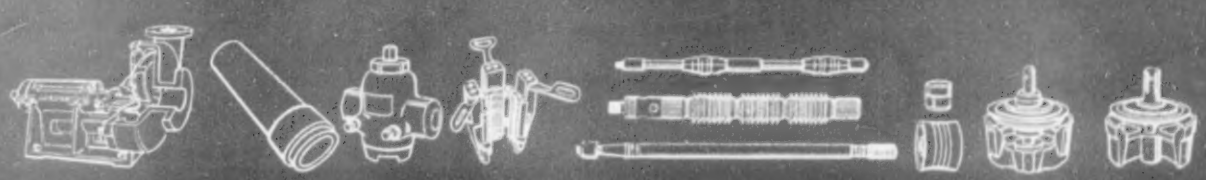
Operated under actual field conditions on a 24-hour "tour," this test pump in the Mission plant at Houston is one more reason why your Mission Pump Parts work better in the field.

Practically every operating condition you can encounter in drilling any place in the world is rolled up into one simulated operation. For example, old mud taken from various field pits and containing cuttings and high sand content is used to duplicate actual conditions. The unit operates at temperatures up to 140 degrees which is higher than average normal field conditions and at pressures in excess of 1500 pounds.

This type of practical testing and probing on old and new design products in the Mission plant assures you that any pump that is all-Mission equipped has a far better chance for a longer, trouble-free life. So be practical about your slush pump parts purchases. Specify all-Mission to your supply store. You can be assured you will get more service per dollar with Mission products in your pumps.

**MISSION**
**MANUFACTURING CO.**

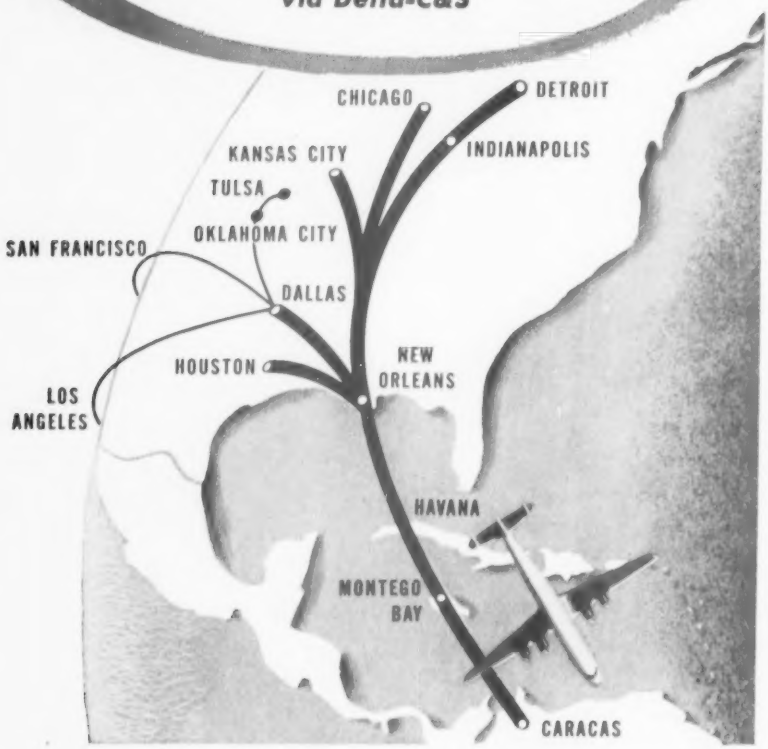
**P. O. BOX 4209 • HOUSTON, TEXAS**
**Export Office: 30 Rockefeller Plaza, New York**



Every Major U.S. Oil Center is

**Within 24 hours of Venezuela**

via Delta-C&S




Through-plane service from the West Coast to New Orleans,* fast connections from Oklahoma, express Constellations straight through from Chicago—all coordinated to land you in booming Caracas first thing in the morning.

There's a 300 mph Luxury Constellation every evening from New Orleans at 7:25 with complimentary refreshments and a special French Quarter dinner. Stops at Havana and Montego Bay, Jamaica.

**Delta-C&S and American Airlines interchange service*

**Fastest—Most direct from: HOUSTON DALLAS—NEW ORLEANS SHREVEPORT CHICAGO—ST. LOUIS**

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*. . . the oilman's route to Caracas!*

*General Offices: Atlanta, Georgia*

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may occasionally create local weakness in the prices of that product."

*Message to the stockholders in 1953 annual report, Phillips Petroleum Co.*

# CALENDAR OF EVENTS

**APRIL**

**20-23** Distribution, Motor Vehicles and Corrosion Conference, Operating Section, American Gas Association, Mount Royal Hotel, Montreal.

**21-23** 1954 Southern Industrial Wastes Conference, Manufacturing Chemists Association Southern Association of Science and Industry, and the Texas Chemical Council, Houston.

**21-23** Natural Gasoline Association of America, thirty-third annual convention, Baker Hotel, Dallas.

**22** Illinois Oil and Gas Association, annual membership meeting, Hotel Emmerson, Mount Vernon, Ill.

**22-23** West Texas short course on oil-lifting methods, Texas Technological College, Lubbock.

**24** Fourth John Zink Process Heating Seminar, John Zink Burner Co. plant, 4401 S. Peoria, Tulsa.

**26-28** Southern Gas Association, annual convention, Houston.

**27** Distillation in Practice, second of an Experience in Industry series, Philadelphia - Wilmington section of the American Institute of Chemical Engineers and University of Pennsylvania, University Museum, Philadelphia.

**MAY**

**2- 4** Independent Petroleum Association of America, midyear meeting, Cosmopolitan Hotel, Denver.

**3- 5** American Geophysical Union, thirty-fifth annual meeting, National Academy of Sciences, Washington, D. C.

**3- 5** Air Pollution Control Association, annual meeting, Patten Hotel, Chattanooga, Tenn.

**4-7** American Welding Society, national spring meeting, Hotel Statler, Buffalo, N. Y.

**6- 7** American Petroleum Institute, Division of Production, Pacific Coast district meeting, Statler Hotel, Los Angeles.

**9-12** Liquefied Petroleum Gas Association, annual convention and trade show, Conrad Hilton Hotel, Chicago.

**10-12** Ninth annual Purdue Industrial Waste conference, Purdue Memorial Union, Lafayette, Ind.

**10-12** American Petroleum Institute, Division of Transportation, Products Pipe Line Conference, Warwick Hotel, Philadelphia.

**10-13** American Petroleum Institute, Division of Refining, midyear meeting, Rice Hotel, Houston.

**12-13** Pacific Coast Gas Association, gas supply and transmission conference, Mark Hopkins Hotel, San Francisco.

**14-15** Interstate Oil Compact Commission, General Oglethorpe Hotel, Savannah, Ga.

**16-19** American Institute of Chemical Engineers, Springfield, Mass.

**17-19** American Petroleum Institute, Division of Marketing, midyear meeting, Cosmopolitan Hotel, Denver.

# Faster Penetration!

## IS THE KEY TO PROFITABLE OIL WELL DRILLING...

Globe products consistently have set the pace for high performance. Today, Globe Integral Jet Rock Bits are setting a new standard for oil well drilling . . . substantially reducing drilling costs, and increasing the drilling contractor's percentage of income per well.

Wherever they're drilling oil wells, the story is the same. Globe Integral Jet Rock Bits *always dig in new formation* . . . reducing rotating time as much as 50%.

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Main Office and Plant:
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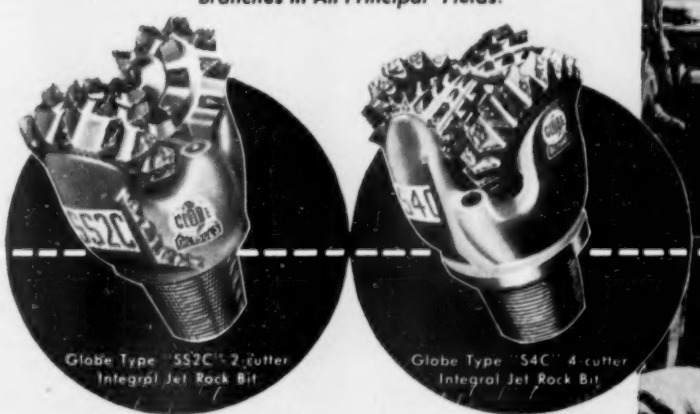
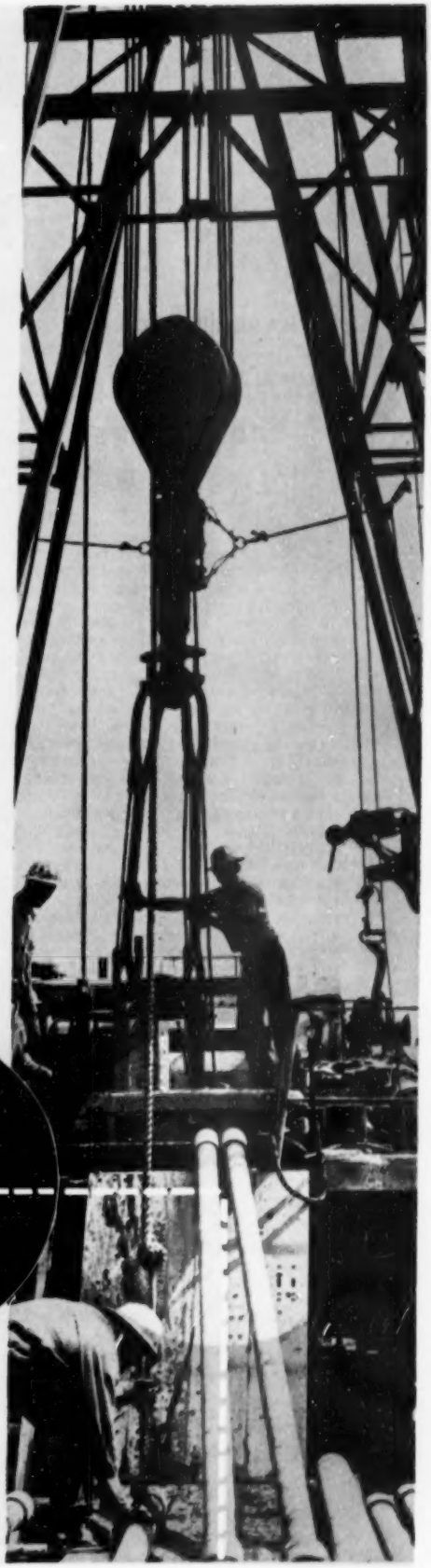



Globe Type S52C 2-cutter Integral Jet Rock Bit

Globe Type S4C 4-cutter Integral Jet Rock Bit



GLOBE INTEGRAL JET ROCK BITS
are setting a *New Standard* for oil well drilling

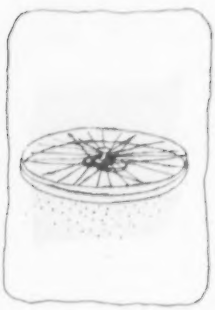
HARBISON-FISCHER

PATENTED

Texas Stripper

ROD PUMPS

for sandy wells



Conventional pumps set in sandy stripper wells often sand up during shut-down periods when sand in the oil column settles around the plunger. Sometimes a tubing job is necessary to retrieve the pump in order to free the plunger.

An outer jacket tube on the Texas Stripper Rod Pump prevents sand from entering the pump; instead sand settles around the pump, and the plunger is not directly exposed to the fluid column. In operation, oil is drawn through the pump in the conventional manner but is discharged through ports in the barrel tube into the annular space between the outer jacket tube and the barrel tube. As the fluid is discharged at the bottom of the skirt the flow action is somewhat agitated which tends to flush sand upward and away from the pump hold-down.

Texas Stripper Rod Pumps (Patented) are available in 1¼" bore for 2" tubing and 1½" bore sizes for 2⅛" tubing, and in a wide range of plunger and barrel tube combinations. Illustrated bulletins giving full information on these and other Harbison-Fischer pumps are available without obligation through leading stores in all major producing areas, from our factory representatives, or by writing us at P.O. Box 127, Fort Worth, Texas.

Harbison Fischer Fort Worth

H·F

OIL WELL PUMPS

20-21 Kentucky Oil and Gas Association annual meeting, Lafayette Hotel, Lexington, Ky.

24-26 American Gas Association, production and chemical conference, William Penn Hotel, Pittsburgh.

27-28 Natural Gas and Petroleum Association of Canada, Prince Albert Hotel, Windsor, Ont., Canada.

31-June 5 American Petroleum Institute, Division of Production, midyear committee conference, St. Francis Hotel, San Francisco.

**JUNE**

2-4 Southern Gas Association, short course in gas technology, Texas College of Arts and Industries, Kingsville, Tex.

3- 4 Pennsylvania Grade Crude Oil Association, thirty-first annual meeting Hotel William Penn, Pittsburgh.

6-11 Society of Automotive Engineers, summer meeting, Ambassador and Ritz Carlton Hotels, Atlantic City, N. J.

13-18 American Society for Testing Materials, annual meeting and exhibit, Sherman and Morrison Hotels, Chicago.

17-19 American Petroleum Institute, Division of Production, eastern district meeting Greenbrier Hotel, White Sulphur Springs, W. Va.

17-19 National Oil Scouts and Landmen's Association, annual meeting, New Orleans.

20-24 Canadian Gas Association, Banff Springs Hotel, Banff, Alta., Canada.

JUNE 20-
JULY 4 Seventh annual Conferences on Personnel Administration and Managerial Development, Industrial Relations Section of the California Institute of Technology, California Institute of Technology, Pasadena, Calif.

24-25 Western Petroleum Refiners Association, regional meeting, Leonard refineries auditorium, Alma, Mich.

25-26 Southern Gas Association, transmission management conference, Hotel Adolphus, Dallas.

27
July 1 Petroleum Equipment Suppliers Association, nineteenth annual meeting Manoir Richelieu, Murray Bay, Que Canada.

**JULY**

23 Southern Gas Association, communications conference, Rice Hotel, Houston.

24 Southern Gas Association, dispatchers' conference, Rice Hotel, Houston.

**AUGUST**

16-18 Society of Automotive Engineers, West Coast annual meeting, Statler Hotel, Los Angeles.

20 Southern Gas Association, natural-gas processing conference, Herring Hotel, Amarillo, Tex.

21 Southern Gas Association, pipe-line operations conference, Herring Hotel, Amarillo, Tex.

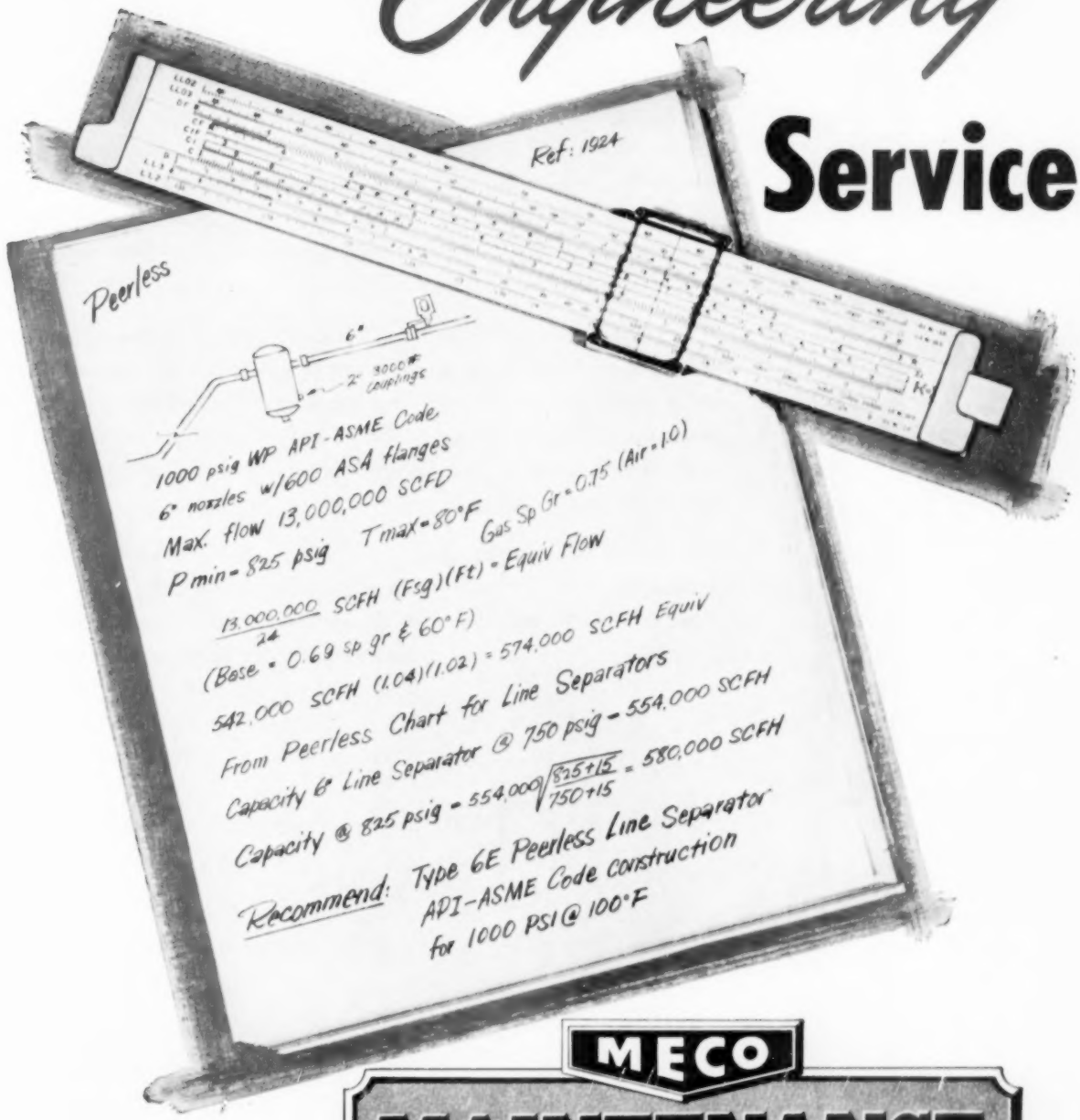
26-28 (tentative) Intermountain Association of Petroleum Geologists, fifth annual field conference, beginning at Price, Utah.

**SEPTEMBER**

7-9 Association of Desk and Derrick Clubs of North America, annual convention, Banff Springs Hotel, Banff, Alta.

8-10 Pacific Coast Gas Association, sixty-first annual meeting, Vancouver Hotel, Vancouver, B. C.

# Equipment with *Engineering* Service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6"
2" 3000# couplings
1000 psig WP API-ASME Code
6" nozzles w/600 ASA flanges
Max. flow 13,000,000 SCFD
P min = 825 psig
T max = 80°F
Gas Sp Gr = 0.75 (Air = 1.0)
13,000,000 / 24 SCFH (Fsg)(Ft) = Equiv Flow
(Base = 0.69 sp gr & 60° F)
542,000 SCFH (1.04)(1.02) = 574,000 SCFH Equiv
From Peerless Chart for Line Separators
Capacity 6" Line Separator @ 750 psig = 554,000 SCFH
Capacity @ 825 psig = 554,000 √(825+15 / 750+15) = 580,000 SCFH
Recommend: Type 6E Peerless Line Separator
API-ASME Code construction
for 1000 PSI @ 100°F

MECO

**MAINTENANCE** *Engineering* **CORPORATION**

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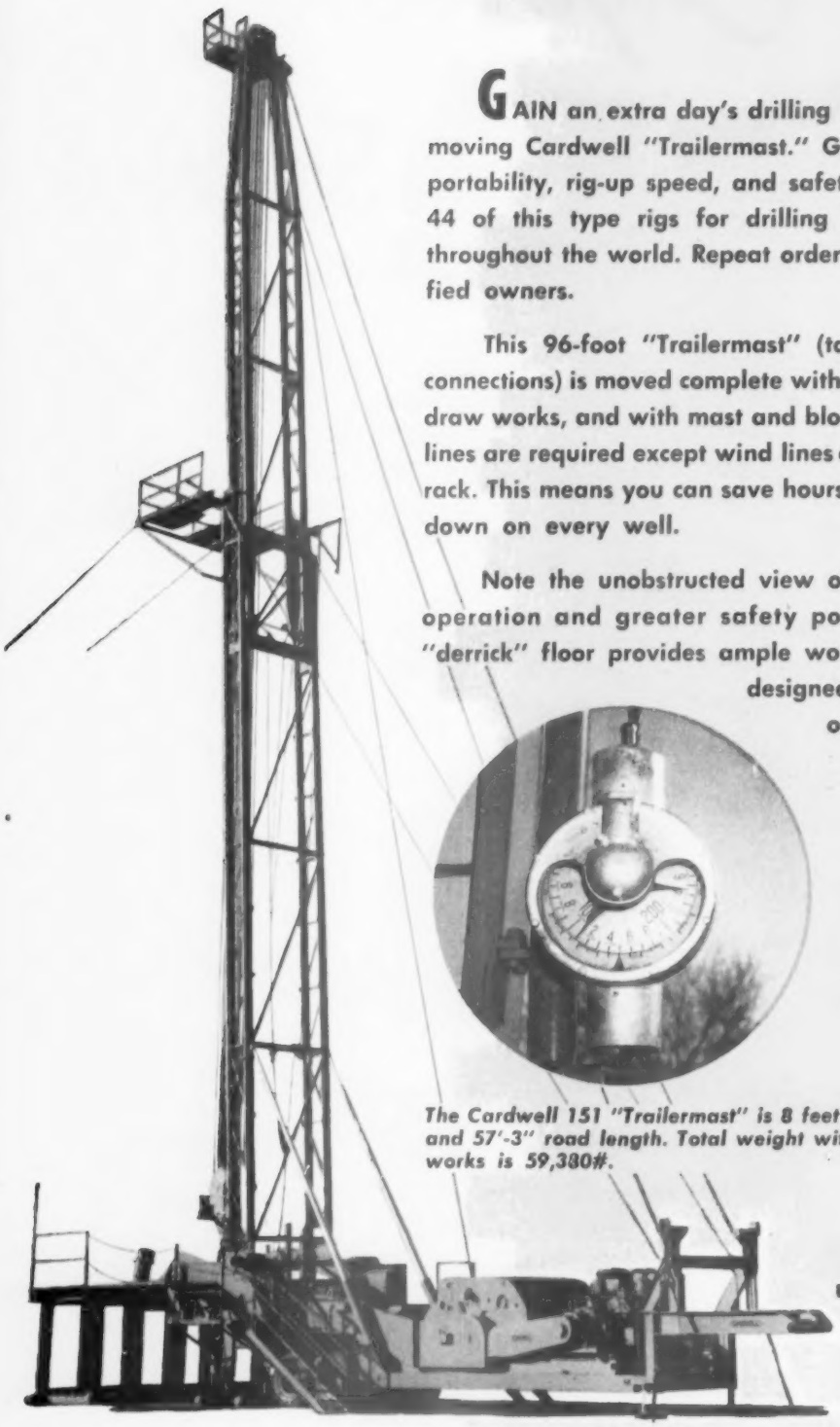
HOUSTON, TEXAS

# The New CARDWELL 151



GAIN an extra day's drilling EVERY week with this fast-moving Cardwell "Trailermast." Gives you the maximum in portability, rig-up speed, and safety. Cardwell has delivered 44 of this type rigs for drilling and workover operations throughout the world. Repeat orders have come in from satisfied owners.

This 96-foot "Trailermast" (tall enough for mousehole connections) is moved complete with a 5,000-foot single engine draw works, and with mast and block fully reeved up. No guy lines are required except wind lines and stabilizing lines to pipe rack. This means you can save hours of rigging up and tearing down on every well.

Note the unobstructed view of the driller makes faster operation and greater safety possible. The big 16' x 16' "derrick" floor provides ample working space. The specially designed trailer eliminates the use of ramps and the substructure permits blowout preventers up to 10 feet high. The "Trailermast" can be used for workover or drilling.



*150,000# with eight lines up.*

*The Cardwell 151 "Trailermast" is 8 feet wide, has 12'-6" road height, and 57'-3" road length. Total weight with double drum Model L draw works is 59,380#.*

# "TRAILERMAST"

RIG UP AND TEAR DOWN IN MINUTES, NOT HOURS . . .

SELF-SUPPORTING. GUY LINES FOLD WITH MAST . . .

ALL WHEELS ON GROUND—NO RAMP REQUIRED

NOTE: *Portable, One-Piece Substructure.*

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THIS TRADE MARK INSURES HIGHEST QUALITY AT LOWEST PRICE

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P. O. Drawer 2001 . . . Long Distance Telephones 128—129—130

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Wichita, Kansas, U. S. A.

# DUAL CONTROL means ECONOMY

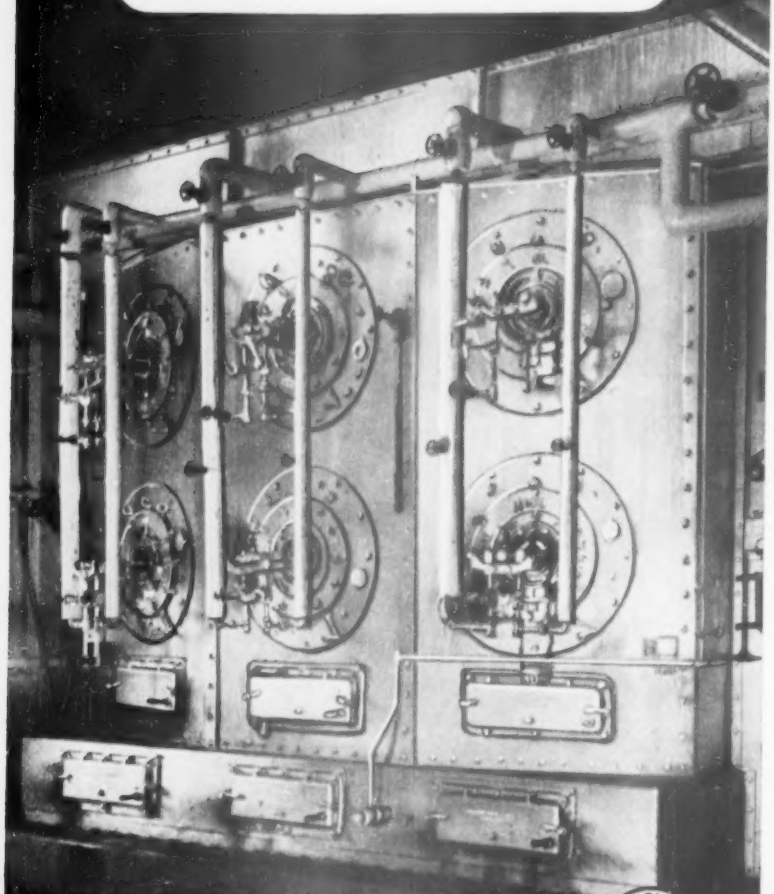
## with NATIONAL AIROIL Universal Registers

### AND TYPE "S-A-L" OIL BURNERS

. . . and economy means that you get better performance with NATIONAL AIROIL Universal Registers because they have a dual feature for controlling air volume independent of turbulence. Air vanes can be instantly reversed to change direction of turbulence while air volume is separately regulated by a refractory faced disk control. Both adjustments can be made while the Type "S-A-L" Oil Burner is firing.

Another "dual advantage" of NATIONAL AIROIL Universal Registers is that they are equipped for dual fuel firing of gas and oil.

Universal Registers with Type "S-A-L" Burners are available in three (3) sizes . . . capacities up to 60,000 lbs. of steam produced per burner per hour. Write for Bulletin 51.



NATIONAL AIROIL BURNER INSTALLATION
BRITISH AMERICAN OIL COMPANY

NATIONAL AIROIL BURNER CO., INC.

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INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT


9-11 Interstate Oil Compact Commission, Omaha, Neb.
12-16 American Institute of Chemical Engineers, Colorado Hotel, Glenwood Springs, Colo.
13-14 Independent Natural Gas Association of America, annual meeting, Roosevelt Hotel, New Orleans.
15-17 National Petroleum Association, fifty-second annual meeting, Traymore Hotel, Atlantic City, N. J.
16-17 Mid-Continent Oil and Gas Association, Louisiana-Arkansas division, annual meeting, Roosevelt Hotel, New Orleans.
23-24 Western Petroleum Refiners Association, regional meeting, Henning Hotel, Casper, Wyo.
25 Southern Gas Association, compressor-station conference, Captain Shreve Hotel, Shreveport, La.
27-29 Electrical Conference for Petroleum Industry, American Institute of Electrical Engineers, Mayo Hotel, Tulsa
27-30 Ninth Annual Petroleum Mechanical Engineering Conference, petroleum division of the American Society of Mechanical Engineers, Statler Hotel, Los Angeles.

**OCTOBER**

2 Southern Gas Association, right-of-way conference, Peabody Hotel, Memphis, Tenn.
4-6 Texas Mid-Continent Oil and Gas Association, annual meeting, Plaza Hotel, San Antonio, Tex.
4-6 Petroleum Electric Power Association, twenty-sixth anniversary meeting, Jung Hotel, New Orleans.
7- 8 California Natural Gasoline Association, twenty-ninth annual fall meeting Ambassador Hotel, Los Angeles.
7-8 American Institute of Mining and Mettallurgical Engineers, Pacific Petroleum chapter, fall meeting, Biltmore Hotel, Los Angeles.
9 Southern Gas Association, field production of natural gas roundtable. Rice Hotel, Houston.
11-13 American Gas Association, annual convention, Atlantic City, N. J.
11-13 American Association of Oilwell Drilling Contractors, annual meeting, Biltmore Hotel, Los Angeles.
12-15 Eighth National Chemical Exposition. Chicago Coliseum, Chicago.
14-17 Permian Basin Oil Show, Odessa, Tex
16 Southern Gas Association, transmission management conference. Rice Hotel, Houston.
17-20 American Institute of Mining and Metallurgical Engineers, petroleum division, fall meeting, Plaza Hotel, San Antonio.
24-26 Independent Petroleum Association of America, annual membership meeting Mayo Hotel, Tulsa.
26-27 Society of Automotive Engineers, national diesel engine meeting, Statler Hotel, Cleveland.

**NOVEMBER**

4-5 Society of Automotive Engineers, national fuels and lubricants meeting Mayo Hotel, Tulsa.
8-11 American Petroleum Institute, thirty-fourth annual meeting, Conrad Hilton Hotel and Palmer House, Chicago.

28-Dec.
3 American Society of Mechanical Engineers, Statler Hotel, New York.

**DECEMBER**

2-4 Interstate Oil Compact Commission, winter meeting, Drake Hotel, Chicago.

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THE OIL AND GAS

# JOURNAL

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# JOURNALLY Speaking

## Horn of Plenty

THE Polk-A-Dots dance band at the Pacific Coast Club had never played with such verve and swing as it did that Saturday night. And not just because its young (23) leader, Jack Crawford, was also first trumpet in the Long Beach Philharmonic Orchestra. Trumpeter-geologist Crawford had just brought in his first oil well.

The Polk-A-Dots had earned Jack a degree in geology at the University of Southern California, kept him eating last summer and fall while he made his own geological reconnaissance of the Huntington Beach area, paid for a lease on a promising location passed over by other oil hunters, and financed the drilling of a well. When the Crawford 1 Huntington came in for 200 bbl. per day of 27°-gravity clean oil, Jack fondled his trumpet, blew a loud clear note, and decided to keep right on calling the tune for both his oil venture and the Polk-A-Dots.

In Long Beach they call Jack Crawford the youngest oil producer in the nation. Undoubtedly he is the first to blow in an oil well through a trumpet. Other, more famous, musicians have entered the oil business through the back door as royalty owners or silent partners, but Jack has proved that he is a geologist and oil finder in his own right. His experience proves again several old adages, such as: Oil is where you find it; there's plenty of opportunity for an independent in the oil industry; and it pays to blow your own horn.

## Welcome, Wanderer

CIRCULATION managers use every trick of the letter-writing art in wooing and keeping desired subscribers. If one type of approach fails to bring the desired results, they are always able to write a different style of letter which may bring in the stragglers. Hard selling, soft selling, cajolery, innuendo, premium offers, humor, personal pleading—all conceivable devices for influencing people are strings for their bows.

But sometimes everything fails and occasionally one even backfires. This was the sad experience recently of the circulation manager of one of our esteemed competitors — though he doesn't know it yet. One of his subscribers apparently was quite delinquent in sending in his renewal check, so the manager attempted to play on his heartstrings with a chatty, homy letter. He compared himself to the man's own mother who used to lie awake nights waiting for the sound of her son's key in the door and the assurance that he had not left home.

But this subscriber was a real runaway. With crass lack of sentimentality, he wrote on the bottom of this touching missive, "I desire to leave home—and go to The Oil and Gas Journal"—and sent it (with check) to our own circulation manager. Too bad, brother; some days you just can't make a dime.

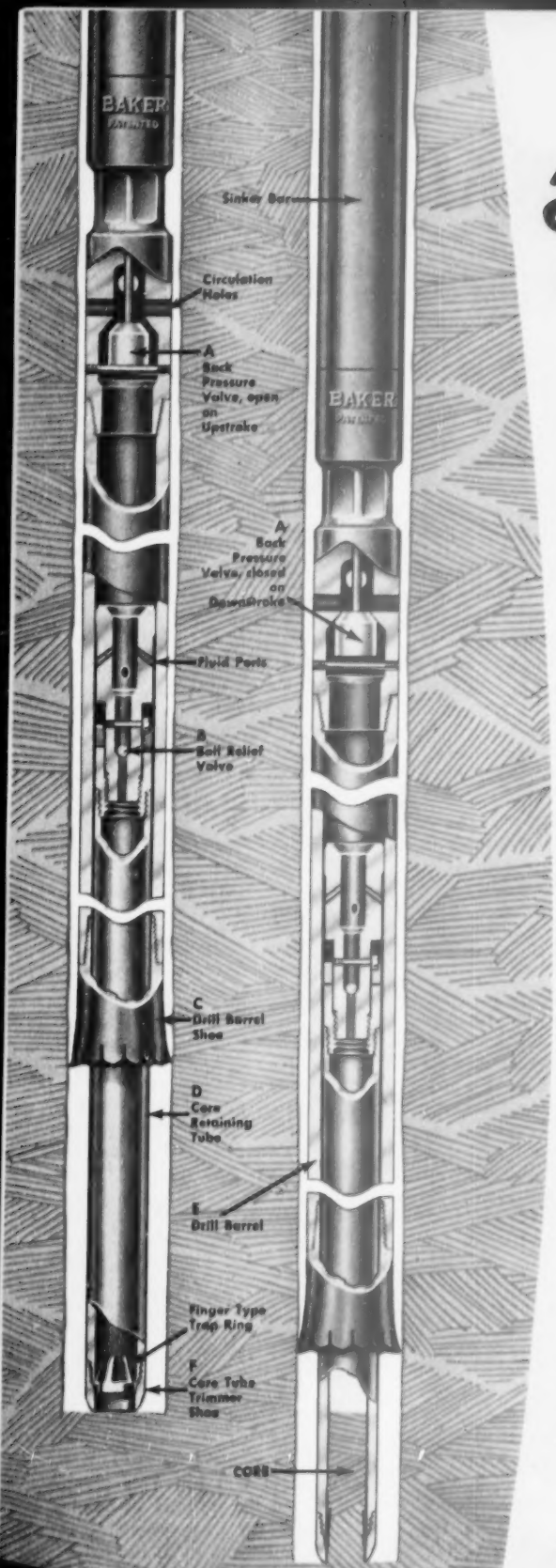
## Phony Gusher

GUSHERS are so much a thing of the past that a synthetic one had to be created recently for a movie to be shown soon on the Du Pont company's Cavalcade of America television program.

It's the story of Spindletop, and the director needed an old-time wooden derrick and a set of rotary tools authentic for the early 1900's. General Petroleum Corp. had such a derrick which had stood for 30 years in the Kern River fields, one of the few not yet removed. And by scrounging junk piles throughout California, G.P. crews found enough old parts to assemble a working replica of an old rig.

Making the well blow in wild was a more difficult problem, but this was solved when Halliburton Oil Well Cementing Co. moved some powerful pumps just out of camera range and pumped in a mixture of water and lamp black at 600 psi. This phony gusher served the purpose so admirably that for the final scene it even blew off the derrick (with the aid of a charge of dynamite after the legs had been sawed through). Never underestimate ingenuity of an oil man.

*—Henry D. Ralph.*

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Coring with a Baker Cable Tool Core Barrel is extremely economical, with operating and maintenance costs held to a minimum. With proper care, this Core Barrel will last indefinitely, and replacement or re-building of the few wearing parts is necessary only after prolonged service.

**Advantages of Coring with the Baker Cable Tool Core Barrel**

Cores up to $2^{13}/_{16}$" in diameter, and up to 7 feet in length are readily taken from a wide variety of formations.
The accurate, uncontaminated cores eliminate danger of passing through low-pressure sands that might prove productive.
Tests for porosity, saturation and permeability can be made without difficulty, and *positive proof* of the *exact character* of any sand is ensured. And all of these advantages are secured with little loss of drilling time, as a Baker Cable Tool Core Barrel takes perfect cores at a speed comparable with straight drilling.

**Strong and Long Lasting—Easy to Operate**

The sturdy construction consists of an outer Drill Barrel (E) and an inner Core Retaining Tube (D). The Trimmer Shoe (F) remains in contact with the formation until the core is taken, after which the entire Core Barrel (with core intact) is removed from the well.
The Drill Barrel (E) slides along the Core Retaining Tube (D) and cuts away the formation, thus permitting the Core Retaining Tube to follow down over the undisturbed core and secure a true sample of the formation.

Features which assist in taking good cores include: the Ball Check Valve (B) which permits escape of water entrapped in the Core Retaining Tube so that fluid under pressure never acts on the core; also, the Back Pressure Valve (A) which closes on the downstroke so that water in the annulus between the two Barrels is driven downward with sufficient force to keep the teeth of the Drill Barrel Shoe (C) free from cuttings.

*ANY BAKER REPRESENTATIVE, or office, can furnish additional details on this efficient, low-cost Core Barrel, which provides many advantages in cable tool drilling.*

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# BAKER

Product No. 520

# CABLE TOOL CORE BARREL

# Independents recognize their interdependence

SOME eyebrows were raised when the Texas Independent Producers and Royalty Owners Association at its annual meeting presented an award of appreciation to a major oil company—and for a refining process.

Was TIPRO losing its independence? Was it "getting into bed" with the majors? Was it branching out into the refining field? None of these things. But the action makes a lot of sense and dramatizes some facts about the oil industry which are often overlooked.

Independent producers compete vigorously with the majors in finding and producing oil, and they demonstrate their independence by fighting every action of the majors which they think is contrary to their interests.

But they are very much dependent on the big integrated companies for markets, for transportation, and particularly for research. Only a big aggregation of capital and technical brains, such as is represented by a major company, can conduct the research which has done so much to increase efficiency and reduce costs in every branch of the industry.

INDEPENDENTS BENEFIT directly from the majors' research on exploration, drilling and production because they can apply the new technology to their own operations. Less recognized but no less real are the benefits from the majors' research on refining techniques which yield new and better petroleum products, cut processing costs, and provide better markets for crude oil.

So it is not only logical but highly fitting for these Texas independents to make public recognition of their debt to the majors and their appreciation of scientific research in all branches of the industry.

Only time will tell whether or not the process picked for this first TIPRO award, fluid coking, will fulfill the optimistic expectations of its originator, Standard Oil Development Co., in making a multitude of high-value products from low-grade crudes and residuals. The significant thing is the breadth of vision exhibited, the demonstration of unity on common problems of majors and independents.

THIS INDUSTRY is peculiar for its coexistence of competition and cooperation, of independence and interdependence, throughout its operations. That is the secret of its strength and its progress, too little understood by outsiders.

Oil is one big integrated industry in which a development in one segment affects all others. At the same time it is hundreds of specialized competitors trying to cash in on the progress and mistakes of others. In that sense there is no such thing as a truly independent in the oil business.

# PRODUCTION INCREASED 400 BOPD WITH STRATAFRAC TREATMENT

## The well still flowed its allowable of 303 BOPD three months after Dowell Service

Dowell used Stratafrac to fracture an old well in a sand formation having high permeability and low solubility. Production was increased from 50 BOPD to 450 BOPD, flowing on a ¼-inch choke. Three months after treatment, the well was still making its allowable of 303 BOPD on a 7/64-inch choke at a tubing pressure of 470 psi.

Stratafrac is used to fracture and acidize formations in *one* operation! Its hydraulic action is designed to extend existing fractures and create new ones. And the acid-kerosene gel (Jel X 500) contains chemicals to dissolve the acid-soluble particles. The sand used in Stratafrac acts to prop and abrade the fractures, creating lenses of artificial permeability. The amount and size of sand used and the acid concentration of the Jel X 500 can be varied to fit formation characteristics.

A recent trend in fracturing has been the development of batch treatments. In this method, the first slugs of fracturing fluid contain a fine grain sand, and the following slugs contain a coarse grain sand.* The fine grains prop an initial opening in the formation to facilitate the entry of the larger grains which follow in the second batch. This contributes to a larger ultimate fracture permitting easier fluid drainage to the well bore.

For more detailed information about Stratafrac and how it can help increase your oil production, contact your nearest Dowell station at your convenience. Or, write to Tulsa. Dept. D-11.

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# THIS WEEK . . . . . IN THE NEWS

**FIRST ELEVATED-DECK barge equipped with self-stabilizers is launched by The California Co. in New Orleans just before final outfitting for drilling at Main Pass. The new barge makes use of hydraulically controlled stabilizing columns which custom-fit it for drilling in varied depths of water. The barge columns, equipped with pontoons, are lengthened or shortened hydraulically until the base rests on the ocean floor. Ballast tanks are flooded to increase stability. (See story on barge's operation, page 107.)**

**OFFSHORE**—A.A.P.G., S.E.G., and S.E.P.M. members told offshore reserves are key to keeping production in pace with growing domestic demand. . . . Consumption predicted to hit about 10 million barrels daily by 1960. . . . ¶Stanolind and four-company operation making final arrangements to spud wildcats in government-controlled shelf off Texas and Louisiana. . . . One of pair expected to drill first well within 2 weeks. . . . ¶Elevated-deck drilling barge that "crawls" up and down during raising and lowering operations undergoing final outfitting for service along Louisiana coast. . . .

**PIPELINE**—Wyoming commission approves sale of Plains Pipeline system to Franklin County Coal Co. . . . System provides outlet for several producing fields in Wyoming. . . . ¶Gulf Interstate resumes work on big-inch gas line from Gulf Coast to West Virginia. . . . ¶Microwave transmission up to 300 miles believed possible through a new approach to radiowave propagation called "forward scattering." . . . Further testing will be required before importance of the new idea to the pipeline industry can be determined. . . .

**INTERNATIONAL**—International consortium negotiators begin talks in Teheran with Iranian Government in last lap of effort to return Iran's oil to world market. . . . Final proposals being made Iran by international group have not been disclosed. . . . ¶Pacific Western geologist sets Wafra field reserve at a billion barrels. . . . He placed recoverable oil at 429,000,000 bbl. . . . ¶Lucky Strike Drilling Co. plans wildcat in Australian concession. . . . ¶Turkey opens door to foreign companies after passage of new oil law. . . .

**REFINING**—Champlin Refining Co. sells assets to Chicago Corp. in $55,000,000 deal. . . . Two refineries among properties acquired by Chicago Corp. . . . ¶Octane parade continues as three firms announce super gasolines. . . . ¶Construction started on $15,000,000 expansion and modernization program at Esso Standard Oil Co.'s Baltimore refinery. . . .

**GOVERNMENT**—Interior officials launch full-scale effort before Senate committee to restore House-slashed budget appropriations. . . . They insist H-bomb makes new studies of defense facilities in industry a must, plead for funds to operate OGD as planned. . . . ¶Bureau of Mines closes Bradford, Pa., field office. . . . ¶Navy plans another 15 wells on Elk Hills Naval Reserve. . . . ¶FPC serves notice it wants briefs filed with it to be more specific and less voluminous. . . .

**EXPLORATION**—Continental expected to spud in a wildcat shortly in Washington's Gray Harbor County. . . . Test will be first of a series for extensive holdings of the company in the state. . . . ¶Monterey going through a "dry run" on shore with the rig it will use on its drilling island now under construction 1½ miles off Seal Beach. . . . ¶Stanolind recovers 1,475 ft. of 39°-gravity oil in South Greenwood field, in extreme southwestern corner of Kansas. . . . Only one other well in the county is producing oil.

**NEW OFFICERS of the Society of Exploration Geophysicists were installed at the close of the organization's annual meeting in St. Louis April 12-15. Left to right are Dr. Milton B. Dobrin, Magnolia Petroleum Co., Dallas, who continues his 2-year term as editor; H. M. Thralls, Seismograph Service Corp., Tulsa, secretary-treasurer; Paul L. Lyons, Anchor Petroleum Co., Tulsa, president; Roy F. Bennett, Sohio Petroleum Co., Oklahoma City, vice president; and Roy L. Lay, The Texas Co., Houston, outgoing president, who will serve as a member of the 1954-55 executive committee.**

# Hope Lies Offshore

## Underwater fields must be depended on to keep domestic production close to demand, Petersen tells geologists

**Frank J. Gardner**

ST. LOUIS.—It is pretty well agreed that the offshore reserves of oil probably represent this nation's greatest single hope for maintaining production at a rate close to our increasing domestic demand.

This fact was brought home to some 4,000 geologists and geophysicists by T. S. Petersen, president of Standard Oil Co. of California in his "New Horizons" address to the 1954 annual meeting of the American Association of Petroleum Geologists, the Society of Exploration Geophysicists, and the Society of Economic Paleontologists and Mineralogists here last week.

It may be that the United States will never again produce all of the crude oil needed in this country, Petersen emphasized, but the offshore areas as the last great outpost of potential production, should certainly be developed as far as it is economically possible to do so.

**Consumption rising . . .** Petersen cited a rise in the domestic rate of consumption from less than 5 million barrels per day at the end of World War II to about 8 million barrels per day at the present time. He predicted that by 1960 this figure would grow to about 10 million barrels.

Against this demand, we have managed to build up crude production from 4.7 million barrels daily in 1954 to 6.5 million at present. Even with the addition of 600,000 bbl. of natural-gasoline production, we are about 1 million barrels short of our needs, according to Petersen.

Obviously, he continued, this makes the United States an oil-producing nation.

**Offshore outlook . . .** At the present time, he said, offshore fields are producing very little—about 12,000 bbl. a day in the Gulf of Mexico and 55,000 bbl. in the underwater fields adjacent to the coast of California.

The National Petroleum Council, Petersen said, has made extensive studies of offshore areas and estimates that in the next 5 years or so, production from the submerged lands can reach a daily rate somewhere between 170,000 bbl. and 200,000 bbl. a day.

In order to accomplish this increase, Petersen said, there are a number of factors which "must remain favorable to such oil development." These include:

**. . . Lower costs:** "Engineers familiar with offshore operations must whittle away at operating costs, which so far probably have been as great a deterrent as any factor affecting exploration over the water. One example . . . is a recently developed rig which can drill six wells from one platform position without being moved."

**. . . Price incentive:** "Just remember that oil produced from under the sea brings no greater price in the market . . . has no greater value to the refiner . . . just because it costs three times as much to find it, produce it, and get it to a shipping point."

**. . . Competent geology:** "Another important factor . . . and I don't think this can be overemphasized, is the necessity for unusually competent geologic counsel. The geologist picking a drill site on a flat stretch of water has only a few geophysical and geological signposts to guide him. And when he has made his decision, he knows it is going to cost someone a great deal of money to find out if he made the right selection."

**. . . Adequate financing:** Petersen then dwelt upon the necessity for adequate financial backing for geologists and engineers. "Behind them," he said, "there must be operators to lay out the money it takes to get started in the offshore areas. They must also be operators working with a long-range view, for offshore development takes time as well as money."

"Standing as witness to the necessity for these characteristics are two figures. One of these is $260,000,000 . . . The amount which it is estimated last year the oil industry had invested in the Gulf of Mexico. The other figure is $50,000,000 . . . the total return to date on this investment, which began to build up back in the 1930's."

**Incentives needed . . .** Petersen then

called for incentives to encourage oil operators in the search for offshore oil.

Foremost among these was was an adequate price structure for crude oil. It is significant, he said, that the oil industry made no real attempt to develop coastal fields while the price of crude oil remained relatively low.

"I believe," he continued, "that more than coincidence marks the fact that 1947 was the year in which several major oil companies began to go after offshore production in earnest, and was the year in which the price of 34°-gravity crude (Gulf Coast) rose from $1.81 a barrel to $2.70 a barrel as price controls were removed. This same crude oil today is quoted at $3.11 a barrel. It must remain at a stable and favorable level if we are to continue development of these potential producing fields."

"Continuation of the 27½ per cent depletion allowance is a vital necessity to provide another incentive for this exploration. If this incentive were reduced or removed, he emphasized, there would be a great inclination to forget the offshore reserves entirely and to turn further toward foreign petroleum sources.

**INCOMING AND OUTGOING OFFICERS of the American Association of Petroleum Geologists are shown at thirty-ninth annual meeting of the association in St. Louis April 12-15. Seated, left to right, Morgan J. Davis, Humble Oil & Refining Co., Houston, former president; Edward A. Koester, consulting geologist, Wichita, Kans., president; John Emery Adams, Standard Oil Co. of Texas, Midland, outgoing president; Elliott H. Powers, Southern Production Co., Fort Worth, secretary-treasurer; and Armand J. Eardley, University of Utah, Salt Lake City, editor. Standing, left to right, Graham B. Moody, Standard Oil Co. of California, San Francisco, vice president; and Leslie M. Clark, Pacific Petroleums, Ltd., Calgary, Alta., outgoing vice president.**

**Cooperation required . . .** Because much of the potential production in the Gulf of Mexico lies within the borders of Texas and Louisiana, another incentive will stand or fall, Petersen said, on the basis of allowable production rates set by those two states. This applies also to the federal lands beyond state boundaries.

"It is necessary . . . that state and federal regulatory bodies continue to recognize this economic reality as the State of Louisiana has done and set allowables for the offshore fields which are high enough.

"The same sort of cooperation must be forthcoming from the state and federal governments in their leasing agreements on submerged lands. Without it, these leases can effect various limitations on oil operators which will amount to the same thing as these governments pricing themselves right out of the oil royalty market."

**West Coast . . .** On the West Coast, Petersen said, development of California's submerged lands will also depend upon cooperation of state and municipal bodies.

At present, under California law, the State Lands Commission may lease submerged lands only when they are being drained or are threatened with drainage from existing fields. In addition, operators may drill only from onshore sites, filled lands, or existing piers.

"A further deterrent on the West Coast is the present practice of imposing a sliding scale of royalty payments ranging from 12½ per cent to 45 per cent, depending on the rate at which a well or a field is produced. These provisions of the California law must certainly be amended if there is to be any extensive wildcat exploration of the reserves lying off the West Coast."

Unless we do these things and grant oil operators these incentives, the valuable offshore reserves may remain largely unproduced for many years to come. But under favorable conditions, the development will become a noteworthy achievement by the oil industry, and one which will benefit the American economy for many years in the future, the speaker concluded.

**What it costs . . .** As an example of what it takes in cash outlay to go exploring on the high seas, Petersen cited the experience of The California Co., largest producer on the Gulf Coast.

For preliminary exploration, plus leases and equipment, this company paid out more than $7,000,000 before spudding its first offshore well in July 1948. It had paid out about $9,000,000 before the first oil was brought in a month later.

"This . . . is a lot of money," he pointed out; ". . . however, it might have been much more, because The California Co. was lucky. It found two good fields in its first four wildcat ventures . . . You know how seldom this happens in rank wildcat territory."

# Safety Pays Off

## Geophysical-firm savings cited in S.E.G. symposium

ST. LOUIS.—Safety programs in geophysical prospecting are paying propositions, the Society of Exploration Geophysicists was told here last week by Bart W. Sorge in a safety symposium presented before the society.

During the past 3 years, Sorge said, companies participating in the S.E.G. safety program have reduced the number of accidents more than 60 per cent. This lower accident rate has resulted in a total saving to the companies of at least $3,000,000, he decleared.

It is unfortunate, he said, that only about one-third of seismic contracting companies are active in safety work.

In the S.E.G. presidential address presented by Roy L. Lay before a joint meeting of the society with the A.A.-P.G. and S.E.P.M., Lay said that accident reduction resulting from the society's program has resulted in a saving of at least $750,000 in direct costs and insurance rates.

The outgoing S.E.G. president told the joint session that the role of the geophysicist is increasing in importance and his assignments are becoming more difficult.

"The geophysicist today is a scientist, business man, and a salesman," Lay declared.

# Migration Proved

## Texaco traces oil from sea; geologists also get details of Carter's identification of source rocks in Uinta basin

ST. LOUIS.—Whether oil migrates or originates within the rock in which it is found was touched on in two papers presented here at the annual joint meeting of the A.A.P.G., S.E.G., and S.E.P.M.

W. S. Olson, supervising geologist of The Texas Co.'s foreign producing department, said Texaco's Velasquez field in the jungles of Colombia, South America, illustrates how oil can migrate from source beds to locations generally held to be unlikely for the presence of oil.

Dr. P. A. Dickey, head of the geology section of Carter's research laboratory, said Carter geologists have completed what is believed the first successful identification of source rocks of certain types of natural oils or asphalts.

**Traces migration . . .** Olson said the Velasquez field is an example of a new frontier in the search for oil since oil turned up in a location that had the earmarks of being very unfavorable for oil.

He said the oil discovered in the South American jungles must have traveled many miles underground from marine source beds. The Velasquez field is about 80 miles south of the nearest known oil field, he added.

Olson said the source beds once lay far to the east of the deep basin which became buried by later rocks. The burial compressed and squeezed the marine waters and oil from the source beds. The oil followed porous sandstones lying just above the basement until it finally lodged against a fault where the continuity of the sandstone was broken.

The field is located in a geological combination that appears as a most unlikely place to prospect for oil. The continental forms in which the oil occurs were laid down by ancient rivers as alluvial fans at the foot of a great mountain range, the Central Andes. These beds rest on granitic basement rocks.

**Key to more discoveries . . .** The original connection used by the migrating oil has long since been broken by mountain-making movements, Olson pointed out. He said only a geologist would suspect that the black shales in the mountainsides of the eastern Andes once contained the oil which is now being extracted in the jungle valleys below.

According to Olson, this knowledge will lead to finding more oil fields in other areas once considered hopeless.

**New approach possible . . .** Dr. Dickey said the source rocks traced by Carter technicians were identified in the Uinta basin of northern Utah. The discovery may throw new light on the migration problem if similar identifications can be made in other areas—and may open a new approach to oil exploration.

"Source rocks have long been a point of conjecture among geologists," Dr. Dickey said. "Some believe that oil originates within the rock in which it is found while others think that oil migrates many miles from its source before reaching a reservoir, thus making it virtually impossible to tie the oil in with source rock or place of origin.

"We believe the work of Carter's research staff in the Uinta basin may open new fields of research on this problem."

He pointed out that by knowing how to identify source rocks, geologists may be able to locate areas which are particularly favorable to oil occurrence.

**Traced four types . . .** By testing more than 2,000 samples of outcrop, the Carter geologists and chemists were able to determine with certainty the source of four distinct types of asphalts and oils, Dr. Dickey said.

He said the source rocks were identified largely through the use of a relatively new analytical tool, the infrared spectrophotometer. The instrument analyzed traces of residual oils found in 60,000,000-year-old rocks. The findings were compared with known oils found in veins, fissures, and sandstone reservoirs in the basin, making it possible to identify each oil or asphalt with a rock of a particular age.

The source rocks in the basin were found to have been deposited in a lake that occupied northern Utah from 30 to 60 million years ago. The environment of the lake and the nature of its contained life changed during its geologic history. These changes were found to correlate with differences in the composition of oils and asphalts that are found in sediments today. These comparisons made it possible to identify the sources of the different oils and asphalts in the basin, he said.

# Wildcat Review

## More oil seen as indirect result of '53 successes

ST. LOUIS.—More major oil and gas fields will be found in this country as a result of a wildcatting stimulus created by significant discoveries last year.

Addressing the annual joint meeting of the A.A.P.G., the S.E.G., and the S.E.P.M., Philip C. Ingalls said 1953 exploration was characterized by the fact that many of the wildcats were drilled either at a considerable distance from production or to a greater depth in areas of shallower production.

Ingalls, geologist in the producing department of Socony-Vacuum Oil Co., Inc., New York and former exploration editor of The Oil and Gas Journal, said many of the 1953 wildcats "broadened and brightened exploratory thinking" in the nation's active oil frontiers.

New discoveries in the Williston basin, he said, expanded considerably the portion of this geologic province believed to contain sizable oil deposits. They also offered some "positive evidence of the potentialities of the rest of the United States portion of this big basin."

# Geologists Honored

## Top award given retired Anglo-Iranian official

ST. LOUIS.—George Martin Lees, retired chief geologist of Anglo-Iranian Oil Co., received the Sidney Powers Memorial Medal at the national convention of the American Association of Petroleum Geologists here last week.

The Sidney Powers Medal was established in 1943 in honor of the late Sidney Powers, fourteenth president of the A.A.P.G. Lees is the eighth geologist to receive the honor. It is considered the highest award in petroleum geology.

The President's Award went to Charles V. Bates, deputy director, division of oceanography, U.S. Navy Hydrographic Office. The award is given annually to the author under 35 years old whose paper is judged the most outstanding in the A.A.P.G. bulletin during the preceding year. Bate's paper on the formation of deltas appeared in the September 1953 issue.

Honorary A.A.P.G. memberships went to two distinguished geologists, John L. Rich, Cincinnati, and George S. Hume, Toronto, Canada, chief of the geological survey of Canada.

# Turkey Invites Industry

## U.S. industry capital, technical know-how asked to aid in development of Turkey's oil after government failure

WASHINGTON. — An invitation to undertake exploration and development in Turkey was extended to the U. S. oil industry last week by Turkish Ambassador Feridun C. Erkin.

Applications for exploration permits are now being accepted by the recently established Turkish petroleum administration under the law opening the country's oil resources to foreign capital, Erkin said *(See International)*.

That law, the ambassador said, lines Turkey up with Israel as the only countries in the Middle East which permit foreign companies to compete with their nationals in the development of their oil resources, reversing a worldwide trend over the past third of a century toward nationalization.

Turkey decided to open up its oil to foreign development a year ago, following years of government efforts to find oil on which $22,000,000 was expended and only two small fields (Raman Dag and Garzan) were discovered. Turkish consumption has increased by 300 per cent in the last 2 or 3 years and reached 7,000,000 bbl. in 1953.

The new Turkish law was drafted with the assistance of Max W. Ball and Elmer E. Batzell, serving as consultants to the government. It is based largely on the United States leasing and tax laws, and places foreign corporations on the same footing as domestic companies, with no restrictions on the export from Turkey of capital, interest or profits from operations *(The Oil and Gas Journal, March 15, page 99)*.

**Law's features . . .** The country will be divided into 8 or 10 petroleum districts based on sedimentary basins, one or two of the largest of which may be split into two or more districts. Nonexclusive exploratory permits and licenses for test drilling will be issued on tracts not exceeding 125,000 acres with not more than eight licenses to be held by one licensee in a single petroleum district. When a licensee makes a discovery, he will be given 5 years in which to define his field and will be given a lease on such land as he selects, not to exceed one-half of the area of the license.

To encourage prompt development, the law provides for a sliding scale of annual rentals ranging from one-half to 3 liras (lira approximately 35 cents), but exploration expenditures may be credited against rentals up to a maximum of 80 per cent.

AMBASSADOR ERKIN . . . an invitation.

Leases will be valid for 40 years and may be renewed from a maximum of 20 years. Royalty will be 12½ per cent of the oil and gas produced.

The law allows the same tax deductions as are allowed by the United States, including a depletion allowance of 27½ per cent or cost depletion, whichever is higher, and permits the operator, at his option, to expense or capitalize exploration expenses, intangible drilling costs and cost of dry holes.

Equipment needed for operations may be imported free of customs duties, and petroleum and products may be exported free of imports, dues or levies.

Lessees will be permitted to engage in any and all branches of the oil industry, including refining and transportation. Others desiring to engage in oil operations other than production will be required to secure permits.

Foreign companies will be subjected to the usual income, property and other taxes, and after an operator has recovered his investment his payments to the government, including rentals, royalties and taxes, will be 50 per cent of his net income.

Some features not contemplated by the two American consultants were included in the law, Ball said. The only burdensome provision is one requiring an operator to send outside Turkey for educational purposes 15 per cent as many Turks as he employs aliens.

The percentage is too high, Ball said, and may be the subject of negotiations for modification.

**New Turkish company . . .** The oil operations previously conducted by the Turkish Government are to be taken over by a new Turkish Petroleum Co. in which the government will hold 51 per cent of the shares and private capital the remaining 49 per cent. This company, incidentally, will be subjected to a higher rate of taxation on its profits than will foreign operators, but it will have superior rights to leases on the areas in which it is now working.

"This law establishes the principles of our policy for the development and use of our petroleum resources through private initiative and investment," Ambassador Erkin said. "We believe that it safeguards and regulates, in the manner best suited to prevailing world conditions, the respective interests of our country and of the companies that bring capital and technical knowledge to the development of our petroleum reserves."

## Steel Dispersal Urged

WASHINGTON.—Dispersal of steel productive capacity as a precaution against an enemy air attack may be as important to the oil industry as the dispersal of refining facilities.

This view of the problem of national defense was given recently by Sen. Price Daniel of Texas in criticizing the mobilization agencies for failure to move quickly and effectively to decentralize vital industries.

Daniel pointed out that it is only in recent years that modern mills for the manufacture of steel products for the oil industry have been established in Texas. In other states to the west of Texas, he said, there is not enough steel production to meet the peacetime needs of the oil and gas industry, let alone those of wartime.

While the Government has been trying to decentralize industry for the past 3 years, Daniel asserted, the progress of the effort has been far from satisfactory and even the most obvious dangers have not yet been eliminated.

# Budget Battle Begins

## Acting OCD director pleads for funds cut from Interior budget, cites H-bomb threat as need for defense studies

WASHINGTON. — A new round of facilities expansion by the oil and gas industry may be required by the perfection of the hydrogen bomb, it was indicated last week.

New military strategy based on atomic air power and possibilities of enemy damage of industrial facilities make previous mobilization expansion goals for the industry obsolete, Hugh A. Stewart, acting director of the Oil and Gas Division, told a Senate appropriations subcommittee in pleading for restoration of funds cut out of the OGD appropriation by the House.

It is obvious that the development of the hydrogen bomb and the reorientation of military strategy now necessary cancel all previous estimates of our ability to provide the oil and gas necessary in the event of war or enemy attack, Stewart said.

New studies have been put under way by the OGD to develop the supply and demand necessary for a war economy in the light of these new conditions.

Stewart appeared before the committee with a group of Interior officials headed by Secretary Douglas McKay to outline the necessity for restoration of funds cut by the House from the requested appropriations for the OGD, enforcement of the Connally Hot Oil Act and oil and gas investigations by the Bureau of Mines.

The OGD, McKay told the committee, should have the $300,000 originally sought if it is to carry out its essential work of correlating and evaluating data on world-wide petroleum supply and demand, domestic production and the use of gas.

The secretary also urged the restoration of $25,000 cut from the fund for Connally Act enforcement, asserting that effective enforcement will require the full amount requested.

Similarly, he said, the Bureau of Mines, as our fuel and mineral requirements increase, is focusing attention more and more on research in fuels in order to find means for augmenting supplies.

"Where it is felt that maximum results have been obtained, such as at the synthetic liquid fuels plant at Louisiana, Mo., which have been discontinued, the bureau's efforts are directed away from such projects and into those where shortages are most acute," McKay assured the committee.

The department's 1955 appropriation bill, passed by the House provided only $100,000 for the Oil and Gas Division, which the House appropriations committee said was comparable to the fund given the OGD beore it was merged with the Petroleum Administration for Defense during the Korean emergency.

Only $125,000 was allowed for Connally Act enforcement as compared with $150,000 for the current year, and $554,215 was clipped from the fund requested for oil and gas work by the Bureau of Mines.

### Bureau Closes Field Office

WASHINGTON. — The Bradford, Pa., petroleum field office of the Bureau of Mines was ordered closed April 15 by Interior Secretary Douglas McKay.

The office was discontinued, McKay explained, because of the difficulty of recruiting highly specialized professional personnel.

The Bradford office, along with that at Franklin, Pa., has been engaged in scientific and technological research on problems of secondary recovery from the oil fields of the Appalachian region and other matters of primary importance to Pennsylvania Grade crude producers.

## Navy Plans Mapped

### 15 new wells are planned on Elk Hills Naval Reserve

WASHINGTON.—Approximately 15 more wells will be drilled in Elk Hills Naval Petroleum Reserve during the coming fiscal year, to combat the migration of oil and an influx of water into the producing sands.

Twenty-two wells already have been drilled under the program developed in 1952 and average daily production has been increased from about 5,000 to approximately 22,000 bbl. daily.

The situation in the naval reserves was explored by a House appropriations subcommittee during hearings on the Navy's 1955 appropriation. Capt. Albert S. Miller, director, and Comdr. Matthew V. Carson, deputy director of naval petroleum reserves, explained the problem presented by a steady

### Cat Cracker Takes Big "Hat"

**Workmen keep a close eye on the 72-ton top section of a catalytic cracking unit as it is hoisted into place at Shell Oil Co.'s Norco refinery near New Orleans. The cat cracker is part of an expansion program that will boost the refinery's capacity 50 per cent, from 50,000 bbl. daily to 75,000 bbl. daily. The cat cracker will have a throughput of 42,000 bbl. per day.**

movement of water which is pressing the oil into one end of the reserve.

The 15 proposed wells will cost an average of $40,000 each, or a total of $600,000, Carson said.

The department's budget included $3,575,000 for all naval oil reserve activities, compared with $2,699,000 provided for the current year and $13,206,045 spent in fiscal 1953, of which $12,633,000 was spent in the development program in the Elk Hills field.

On the basis of presently planned operations, the Navy expects to secure a revenue of $800,000 next year from Naval Petroleum Reserve No. 2 (Buena Vista Hills, California) and $20,500,000 from Elk Hills, Miller testified.

## New Line Planned

### Spanish products system would serve air fields

WASHINGTON.—A 300 to 500-mile oil products pipeline is being designed in the Navy Department to serve a naval base and four large air fields to be built in Spain under a defense agreement with the Spanish Government.

The base, air fields and pipeline are being designed as a unit. The actual route of the line will be determined by the locations selected for the air fields. It will run, generally, however, from the Cadiz Bay area in southern Spain northerly, skirting Madrid and turning in a northeasterly direction. The size of the pipe to be used and the details of operation of the line are currently under study.

Although the design engineering and other planning is still in the initial stage, the Navy has selected its contractors. The over-all project will be handled by Brown & Root, Inc., Raymond Concrete Pile Co. and the Walsh Construction Co. The actual construction will largely be subcontracted to Spanish concerns, under the agreement with Spain which provides that all work which can be so handled is to be done by Spanish nationals.

The initial allocation for the Spanish project is $58,000,000 to $60,000,000 for planning, about 20 per cent of which is estimated to be needed for working out the pipeline. Actual construction probably will not start until next year, and the definite program will depend upon the willingness of Congress to give the department the funds it will ask for. However, as design engineering progresses the Navy will begin the purchasing of equipment requiring a long lead-time for fabrication.

## WATCHING WASHINGTON

**Bertram F. Linz**

### Expediency Aids Depletion

Any effort to change the oil industry's depletion allowance in the tax-revision bill now before the Senate will be resisted by the Treasury Department.

Without revealing his own views on the present 27½ per cent allowance, Secretary George M. Humphrey has expressed opposition to loading the bill with amendments of a controversial nature which might delay enactment of the legislation.

Humphrey's position dims chances for adoption of an amendment to cut the allowance to 15 per cent, filed last month by Sens. John J. Williams of Delaware and George D. Aiken of Vermont.

Administration leaders are anxious that the tax bill be enacted without delay, to give industry and business a much-needed shot in the arm. A number of amendments to the House-approved measure are expected to be brought up for Senate consideration, both during the course of hearings now being held by the Finance Committee and when the bill reaches the floor. Pressure will be exerted to have the bill kept as closely as possible to its present form.

It is expected that another tax bill will be considered next year covering points not included in either the recently enacted excise-tax measure or the pending over-all revision of the internal revenue code. Among them the depletion allowance and other matters which President Eisenhower, in his tax message, said would be subjected to exhaustive study.

### ICC Amendment Sought

Congress has been asked to amend the Interstate Commerce Act and eliminate provisions which exempt from ICC regulation dry-cargo inland water carriers which haul no more than three types of commodities in a single operation.

Although the bill as written would apply principally to carriers of coal and wheat, petroleum and chemical interests see in it the possibility that ICC regulation eventually would be extended to oil and petrochemicals.

Under legislation enacted in 1940 to permit Great Lakes ore and wheat carriers to compete with Canadian vessels, inland water carriers which move three or less bulk commodities in the same load are exempted from ICC regulation.

If the bill, sponsored by a group of eight senators headed by John W. Bricker of Ohio, should get through Congress, carriers subject to its provisions would be required to apply to the ICC for a certificate. They would be limited to the routes they have been using and the commodities they have been transporting during the past 2 years, and would be required to file rate schedules.

The effect would be to put many barge operators on the Mississippi and Ohio rivers on a competitive par with water carriers already regulated and also with the railroads.

That the regulation of dry-cargo haulers might well be followed by extension of regulation to oil carriers was indicated by ICC Chairman J. Monroe Johnson in a report to Bricker on the bill, which he said might not be stringent enough, but "would be a step in the right direction."

### Briefs Should Be More So

The Federal Power Commission wants less fat and more meat in the briefs filed with it.

The briefs filed with the commission reflect great skill, Chairman Jerome K. Kuykendall admits. But, he said, "there seems to be a tendency at times to probe into every possible question upon which there might conceivably be a difference of opinion relative to the individual matters presented in pleadings, regardless of their relative importance to the determination of the issues in the case."

The task of reading these encyclopedic briefs has become so onerous that the commission actually considered adopting a limit on length. However, it contented itself with an appeal for brevity.

"In most of the situations presented for commission determination the issues which are of vital significance are relatively few in number in any single case and can and should be clearly, succinctly and b r i e f l y stated," it pointed out.

And that goes for commission counsel as well as interested parties.

**NEW P.I.E.A. OFFICERS AND DIRECTORS are (left to right): J. A. Fowler, Panhandle Eastern Pipe Line Co., Kansas City, Mo., director; J. A. Polhemus, Jr., Standard Oil Co. of California, San Francisco, president; Tom A. Shaw, Phillips Petroleum Co., Bartlesville, Okla., secretary-treasurer; and Frank Geisel, Atlantic Pipe Line Co., Dallas, director. Not present for the installation were: W. E. Church, Shell Oil Corp., Los Angeles, chairman of the board; Hezzie Clark, Humble Oil & Refining Co., Houston, vice president; and K. P. McCord, Gulf Oil Corp., Pittsburgh, director. Clark was named general convention chairman for P.I.E.A. for 1955 meeting in Houston. Church is the outgoing president of the association.**

# Frequencies in Danger

## Increased common carrier use may bring end to exclusive industry radio bands, speaker warns P.I.E.A.-P.E.S.A.

DALLAS.—An increase in the use of common carrier radio facilities by petroleum companies could result in the loss to the industry of certain exclusive petroleum-radio frequencies.

This warning was given by Joseph E. Keller at the recent annual meeting of the Petroleum Industry Electrical Association and Petroleum Electric Supply Association. Keller is special Washington representative for the Central Committee on Radio Frequencies of the American Petroleum Institute and the National Petroleum Radio Frequency Coordinating Association.

At present, the use of common-carrier service is not widespread enough to be called a trend, Keller said, but it does attract attention. Should the use increase appreciably, it might be interpreted by the Federal Communications Commission as a reduction in the need of petroleum-radio frequencies as such.

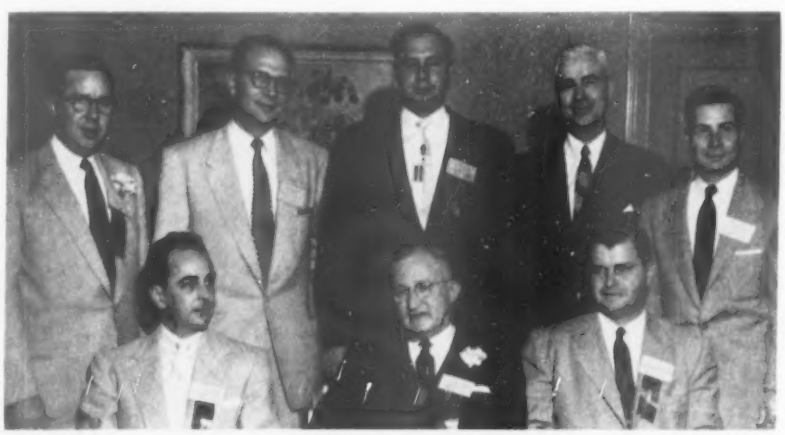
Frequencies for radio service in both vhf. and uhf. ranges were allocated originally by the FCC to the petroleum industry on the premise that service of this type was sorely needed by the industry and could not be obtained from common-carrier sources, Keller said.

Recently several companies have sold entire communication systems to common carriers, retaining radio licenses in the company name and using the systems under lease agreement. Other companies are turning to common-carrier service outside of petroleum-radio frequency bands. Should this practice become widespread it could result in the complete reallocation of frequencies by the FCC and the allowing of unrestricted common-carrier operation on present petroleum frequencies, Keller said. Such an event would be particularly undesirable to members of the industry who retain ownership of radio systems, since petroleum bands are overcrowded now.

**Responsibility . . .** Both Keller and a second speaker, Lester W. Spillane, assistant chief of the Safety and Special Radio Services Bureau, Washington, D. C., told their audience that use of leased facilities did not relieve the user of responsibility for proper operation. Under present FCC rules the operator of a radio system in petroleum bands must retain license and hence responsibility for all violations, whether they are connected with operations or the use of faulty equipment.

Keller stressed that he was in no way criticizing companies who have sold systems or who are leasing systems since each case will stand on economic merits. His discussion, he said, was to keep remaining companies informed of what to expect from the FCC if common-carrier use becomes widespread.

**Band spacing reduced . . .** Both the A.P.I. central committee and the N.P.-R.F.C.A. have been involved in extensive tests to determine the feasibility of operating mobile radio equipment in the 25 to 50-megacycle band on adjacent channels of 20-kc. width. As a result of these tests it has been concluded that such operation is possible and practical with present, commercially available equipment, Keller said.



**TOP P.E.S.A. BRASS FOR 1954-55 will be (front row, left to right): T. C. (Tommy) Savage, General Electric Supply Co., Houston, vice president and 1955 general convention chairman; A. Frank Hamm, Graybar Electric Co. (ret.), Dallas, president; R. T. Shiels, Jr., Anaconda Copper Mining Co., Dallas, secretary-treasurer; (back row): George Jamison, Crouse-Hinds Co., Houston, past president and new chairman of the board; Ed Falls, Motorola, Inc., Dallas, director; Gene Smith, Nelson Electric Supply Co., Tulsa, director; Claude R. Miller, Dallas, general counsel; Sid Talbott, Star Electric Co., Tulsa, director. Not present were Joe Mevis, Nunn Electric Supply Co., Houston, and Dick Thompson, Warren Electric Co., Houston, both directors.**

Present operations in this band is on 40-kc. channel spacing and the adoption of 20-kc. rules would do much to alleviate crowed conditions in the band.

Another development important to the petroleum industry is the petition by the central committee to the FCC that any reallocation of the FM broadcast band should include frequencies for the Petroleum Radio Service. If the industry were allocated frequencies in the present FM broadcast band it would help to offset decreasing value of the 72-76-megacycle band.

**Microwave rule changes . . .** The FCC, recognizing the increased use of microwave, now appears willing to take microwave out of development status and form a permanent microwave service, Keller said. In connection with this the A.P.I. central committee, as the representative of the largest user group, has been asked to analyze the operational needs within the petroleum industry. The committee is cooperating with users in other industries and with the commission to form a complete set of microwave rules and standards, Keller said.

# Radio Struggle Looms

## Common carrier making effort to sell oil, gas industry on private communications; engineers muster resistance

**Robert G. Deering**

DALLAS.—An important controversy is now going on within communication circles of the petroleum and natural-gas industry as to whether companies should own and operate their communication systems or make use of common-carrier service.

Strong attempts are being made by the largest communication common carrier to sell more of its microwave and mobile radio service to the petroleum industry. Industry engineers are resisting these efforts with equal vigor and strength.

A double-barreled approach is being used by the common carrier to sway petroleum and gas top management from privately owned communication systems, according to lobby talk at the recent annual meeting of Petroleum Industry Electrical Association and Petroleum Electric Supply Association.

**Arguments . . . pro . . .** The most-used selling point for common-carrier service is that communication is of secondary importance to the business of producing and transporting oil and gas. Management is being told that use of leased systems will relieve responsibility for operation, eliminate maintenance headaches, and release large amounts of capital for other use.

Second major point in the common-carrier argument is that research organizations, technical skill, and years of operating experience combine to assure more reliable and economical communication service.

**. . . and con . . .** Industry engineers counter that operational responsibility in radio service must remain with the licensee—the oil or gas company. FCC rules prohibit licensing of common carriers within frequency bands allotted to Petroleum Radio Service. Thus a lessee must obtain license and be held accountable for all violations concerning personnel and equipment.

Capital investments, particularly with pipeline companies, are used in establishing rate structures, the engineers say, and are not a financial handicap.

The character of the petroleum industry demands extreme flexibility in system engineering, installation, operation, and maintenance. This flexibility can not be had by use of common-carrier facilities, according to industry engineers, but is possible only if management has direct control over all phases of communication activities.

Final argument in favor of privately owned systems is that operations involving automation and remote control require personnel and material similar to that of communication systems. Thus, use of common-carrier communication involves a duplication of efforts and over-all inefficiency.

It is certainly too early to predict the outcome or even establish a trend in this controversy, but industry engineers, the FCC, suppliers, manufacturers, and members of the common-carrier industry are keenly interested in each new development.

# Big Sale Made

## Chicago Corp. purchases Champlin Refining assets

ENID, Okla.—Chicago Corp. of Chicago and Corpus Christi has purchased the Champlin Refining Co., whose operations include refining, drilling, production, marketing and transportation, in a $55,000,000 deal.

The purchase includes a 22,000-bbl.-per-day refinery here and a subsidiary, Peppers Refining Co., Oklahoma City, which has a daily capacity of 1,750 bbl.

Champlin also sold 400 producing wells in Oklahoma, Kansas, and Texas along with 600,000 acres of undeveloped leases in Oklahoma, Texas, Colorado, New Mexico, Louisiana, North Dakota, and Nebraska.

Also included in the sale were Champlin's pipeline subsidiary, Cimarron Valley Pipe Line Co., which has 385 miles of line, and the firm's drilling concern, Oven Drilling Co.

Chicago Corp. formerly was an investment firm, but now is primarily a producer of oil and natural gas. It was reported several weeks ago that the firm would purchase Champlin, which gives Chicago Corp. its first refining and pipeline properties *(The Oil and Gas Journal, March 8, page 74)*.

# Next Week—Field-Processing Issue

THE OIL AND GAS JOURNAL will take its readers to the field next week in a special issue covering field-processing activities.

Among the features in the special issue will be the Journal's annual survey of field-processing plants, including natural gasoline and cycling plants. The survey will cover 493 plants.

The answers to many of the problems encountered in operating the fractionation section of process plants will be answered in other articles. John C. Reidel of the Journal staff covers instrumentation of fractionators in a special 16-page section.

There will be eight informative papers on fractionator-absorber tray design and operations. These papers have been selected from forums conducted by the California Natural Gasoline Association and the Natural Gasoline Association of America.

The proper design and operation of various field units will be covered in another series of articles.

# New Radio Concept

## P.I.E.A.-P.E.S.A. members told powerful transmitters might permit new microwave links of 200 to 300 miles

**Robert J. Enright**

DALLAS.—"Forward scattering," a new approach to radio-wave propagation may permit microwave transmission up to 300 miles, Dr. Daniel E. Noble told members of the Petroleum Industry Electrical Association and Petroleum Electric Supply Association at the annual meeting here. Noble is vice president of the communications and electronics division of Motorola, Inc.

This, a form of electro-magnetic wave propagation, has been explored over the past few years with "very interesting results," he said. It mounts to radio-wave dispersion in the lower atmosphere not unlike the scattering of light when illuminating areas behind barriers in the path of the light source.

In the past, Noble said, it was thought that the signal provided by such scattering below line-of-sight was of such low level that it would not be usable for communications.

Recent investigations, however, have shown that the actual signal level is literally thousands of times greater than that predicted by conventional theory. By using high-powered transmitters and directional antennas at both ends of a circuit, it has been possible to provide excellent continuous communication between points as far distant as 200 or 300 miles. These experiments used frequencies in the microwave band and involved transmitting over paths in which the curvature of the earth and the presence of mountains made the line-of-sight reception of the direct wave impossible.

Noble said if the promise of forward scattering is fully realized, it should be possible, using high-power transmitters and directional antennas, to provide communications without relay units in locations where there are neither road nor power facilities.

Noble warned, however, that it is still too early to predict that this will happen. Only further testing will tell.

**Cost a vital factor . . .** Automatic control, whether in processing, pipelining, production, or any other industry division, should only be applied where it will result in a reduction of the cost of operation, Noble told the conference.

To install such an efficient operation, Noble said, more is required than a mere delegation of the job by top brass to the engineering and operational level. The approach to the job must be from a systems-operation point of view. It is essential, Noble said, that the operation be derived from top-level planning and be moved down through the organization to define objectives and assign specific design requirements and implementation.

No electronic engineer can walk into a complex petroleum operation and work out an effective, integrated system of control, he said. Over control and over complexity are just as bad as poor control or no control at all. The solution of an operational control problem must be simple and practical, with no frills nor unnecessary electronic appendages.

The ideal approach to the problem will be achieved, Noble said, when top management grants full recognition to the existence and the promise of electronic devices and communications means, and by initiating a study of the over-all system requirements, transmits a broad outline of a plan for lowering petroleum operational costs.

Operational engineers, working with commercial electronics specialists, then can develop the actual operation required for the system, he said.

## Venezuela Assets Listed

NEW YORK.—Trade with Venezuela is a two-way street, and the $850,000,000 which that Latin American republic spent last year on United States exports, from powdered milk to railroad engines, brought economic benefits to workers in 450 American cities in 43 states.

These and other figures on the importance of the purchases which Venezuela's oil income allows it to make in the United States were brought out in a report prepared by Econometric Specialists, Inc., New York for the Venezuelan Chamber of Commerce in the United States and made public last week under the sponsorship of Creole Petroleum Corp.

The study includes a detailed breakdown of where United States goods shipped to Venezuela originate, their classification, and value. The data was based on information supplied by some 1,700 American companies marketing products in Venezuela.

Lloyd G. Smith president of the Venezuelan Chamber of Commerce and a vice president of Creole, said the high level of Venezuela's purchases in the United States—making it our second best export market—are possible only as a result of its continued oil shipments in this country.

# Veteran Journal Writer Dies

W. T. ANDERSON, 85, former managing editor of The Oil and Gas Journal, died April 13 in Tulsa.

Anderson retired in July 1940 after being with the Journal 17 years. He joined the Journal in 1923 as associate editor after 22 years as chief editorial writer for the Pittsburgh Dispatch.

As chief editorial writer, Anderson voiced the Journal's opinions and approaches to the many problems facing the growing petroleum industry. He was quick to sense the need for public-relations work by the industry and vigorously opposed all suggestions of federal control over the oil industry. He also was author of the "Oil Industry's Answer," to federal control published as a special section in the Journal in 1924. It was reprinted in 1927.

Anderson also was a champion of early industry spokesmen who advocated passage of conservation laws in the oil-producing states.

A native of Ireland, Anderson came to the United States in 1891 after working for a newspaper in London. In 1900 he became editorial writer for the Pittsburgh Press and a year later joined the Pittsburgh Dispatch.

## Gas Barge Boosted

### European markets could get Middle East gas via barge

WASHINGTON.—Development of a method for transporting natural gas by water *(The Oil and Gas Journal, March 22, page 104)* is seen in Washington as a possible first step toward opening up European markets for Middle East gas products.

If a method can be perfected for moving liquefied gas over the long haul from the Middle East to Western Europe, it may offer a solution to the problem of making economic use of the gas produced in connection with oil in Saudi Arabia, officials of the Foreign Operations Administration told The Oil and Gas Journal last week.

Suggestions made a year or more ago for the construction of a trans-European natural-gas pipeline are, so far, the only idea brought forth for making use of Middle East gas.

It is not believed there would be any insuperable difficulties in securing transit permits for such a line from the democratic countries through which it would pass. But there is no chance of a line being constructed so long as there is possibility it would be cut by the Russians.

**Study in progress . . .** The FOA is financing a study now being made by the National Academy of Sciences of the possible use in Saudi Arabia of the gas produced by the Arabian American Oil Co., for the production of carbon black, cement and fertilizer.

The FOA is studying a water movement of liquefied gas proposed for the Mississippi River, and has asked a number of interested experts for their views on the possibility of adaptation of the method to the longer Mediterranean haul.

**L.P.G. more practical . . .** FOA oil experts do not believe water transportation of methane would be practical for the European situation. They do believe, however, that it might be possible to liquefy and ship butane and propane which Aramco is in position to extract from its natural gas. Those two products, it is pointed out, would not have to be cooled as deeply as does methane and they would have a wider market.

As in the case of the plan proposed for the Mississippi movement, the refrigerating possibilities in the vaporizing of the gas could be used and the revenue might do much to make the European project economic.

Some markets might be developed in ports of all countries bordering the Mediterranean except Italy, which has natural gas of its own. France, however, is considered the largest likely market, at least initially.

## A.S.M.E. Plans Meeting

TULSA.—A panel session on unfired pressure vessels will be one of the main features of interest to the petroleum industry of the fifth annual meeting of Region VIII of the American Society of Mechanical Engineers here April 25-28 in the Mayo Hotel.

David E. Fields, vice president of Flint Steel Corp., Tulsa, will be moderator for the panel session, scheduled from 9 a.m. until noon of April 27.

A.S.M.E. boiler code subcommittees on openings and bolted flange connections, and on unfired pressure vessels and welding will meet on the twenty-sixth.

Technical papers to be presented at the meeting include: "Electrical Oil Well Pumping With Flexibility," Ted C. Anderson, Jones & Laughlin Steel Corp., Lyons, Kans.; "Construction of Biggest Mississippi River Pipeline Crossing," C. L. Graves, J. Ray McDermott & Co., Harvey, La.; and "Hydraulic Analogue for Solution of Heat Exchanger Problems," Dr. Stephen I. Juhasz, Midwest Research Institute, Kansas City.

# Industry Briefs

**NEW YORK. — More than nine** floors of a new 19-story office building here have been leased by American Oil Co. for its headquarters office. The structure, at 555 Fifth Avenue, will be known as the Amoco Building. Real estate reports were that American Oil would pay between $10,000,000 and $15,000,000 over the 21-year lease.

**EDMONTON, Alta. — The Alberta** government has released figures showing the province's oil industry has outstripped the coal industry. Employment in the coal industry declined from the peak figure of 8,583 in 1946 to 5,760 in 1953, while employment in the oil industry climbed from about 5,000 to 18,200.

**CALGARY, Alta. — Pembina Pipe** Line Co. has been granted a permit to build a crude transmission line from Pembina field in West Central Alberta to a point near the Interprovincial and Trans Mountain terminals a mile west of Leduc. Construction will get under way in several months.

**WINNIPEG, Man.—The first sale of** substantial wildcat acreage for a cash bonus was concluded when California Standard Co. and Imperial Oil, Ltd., paid $65,535 for oil and gas leases on 10 parcels of land offered by the Manitoba government. The parcels are in the vicinity of Roselea and Scallion pools near Virden and east of the Whitewater field.

## A.P.I. Presents Meritorious Service Citations

**Four oil men were presented citations for outstanding service at the spring meeting of the Rocky Mountain district of the American Petroleum Institute's Division of Production in Casper. Left to right are C. H. (Bud) Griffin, of R. L. Manning Drilling Co., Denver; John G. Pew, vice president of Sun Oil Co., and A.P.I. vice president for production; J. Howard Barnett, Casper consultant; and S. J. Lintzenich, Hughes Tool Co., Casper.**

# WEST COAST

## Washington Wildcat

### Continental to drill several wells in Grays Harbor

LOS ANGELES.—Continental Oil Co. is expected to start a wildcat soon in Grays Harbor County, Washington.

The test will be on the Wishkah structure about 25 miles northeast of the area where Union Oil Co. of California and others encountered showings of oil and gas. Designated 1 Fee-Sims, the test will be drilled in SW SW 31-19n-8w.

Continental's test is expected to be the first of several scheduled for its substantial holdings. These reportedly are being evaluated further by core drilling.

Current activity in the state consists of three cable-tool operations. In Pacific County a test spudded last July is being carried on scout reports as drilling below 820 ft. The two other wildcats are in Lewis County. One spudded in February has reached a depth of about 600 ft.; the other was near 450 ft. after having been spudded in March.

Although six deep tests have been failures, the Grays Harbor area has long been recognized as potential oil country.

Union Oil Co. has produced small quantities of high-gravity oil and gas, but the tests were abandoned because of sloughing shales.

### Shell Stakes Wildcat Pair

LOS ANGELES.—Shell Oil Co. has made tentative locations for two wildcats on the Eagle Springs unit in Nye County, Nevada.

Both wildcats will be located south of the 1 Unit, indicated first oil producer for Nevada, which is now drilling below 8,248 ft. in tight limestone. The 2 Unit will be located 9 miles southwest of the 1 Unit, and the 3 Unit about 5 miles south. The two locations are the first announced through the general area of Shell's indicated strike.

### Monterey Readies Rig

LONG BEACH.—Monterey Oil Co. is putting a rig through a preliminary "dry run" at the contractor's yards here to see how it best can be fitted onto the company's 75-ft. diameter drilling island now being built 1½ miles offshore from Seal Beach.

As soon as the man-made island is completed later this month, the contractor, Brown Drilling Co., will barge the rig to the drill site. There it will drill three tests into the 1,125-acre lease Monterey jointly holds with The Texas Co. A well slanted from shore to a point almost underneath the island already has proved the lease will have at least one oil pay.

Because the island does not offer the space normally used on a dry land location, several changes in rig layout are being made. Probably the most unorthodox is the placing of the mud tanks and pumps under the drilling engine floor. To accomplish this 15-ft. sub-bases are being used. This will place the derrick floor about 30 ft. above water level.

### California Offers Leases

LOS ANGELES.—The California State Lands Commission will ask for bids about May 1, on 1,200 acres of submerged lands lying offshore from the Rincon field.

This will be the first such action taken by the body since the federal Government attempted to secure title in 1947.

The irregular shaped parcel to be offered extends seaward about 2 miles, with its northern boundary near Punta Gorda and a portion of its east boundary coinciding with the west limit of General Petroleum Corp. state lease 48. It is anticipated operators will be given about 60 days in which to file their bids.

# MID-CONTINENT

## Oil in Gas Field

### Stanolind's Morton County wildcat recovers 39° oil

WICHITA.—Stanolind Oil & Gas Co. has an indicated Morrow sand (Pennsylvanian) oil discovery in South Greenwood field—an area that now produces only gas.

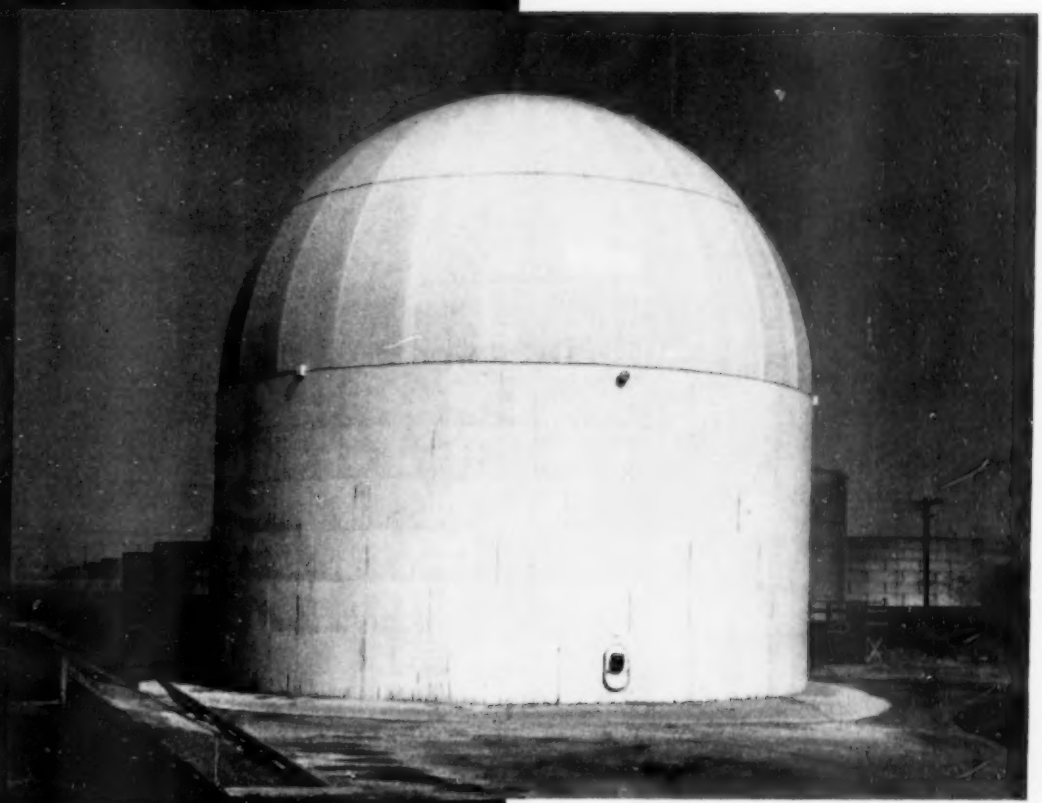
Stanolind's Morton County wildcat, 1 USA Gas Unit C, recovered 1,475 ft. of 39°-gravity oil. It is regarded as of great significance to this southwestern area of Kansas.

Morton County has only one other well producing oil. Its gas production is from the Lansing-Kansas City and Topeka limestones.

### Closing Ports Not Answer, DeGolyer Says

**Everette DeGolyer, frequently referred to as the dean of the world's geologists, said recently in Wichita Falls, Tex., that closing United States ports to foreign oil isn't the answer to the import problem. Speaking at the bimonthly dinner meeting of the North Texas chapter of the American Association of Oilwell Drilling Contractors, DeGolyer said that such action would only result in closing the export markets now open to American crude. Here, DeGolyer (center) chats with Dale Mount (left), executive vice president of the national association, and Frank Denman, Jr., chairman of the North Texas chapter.**

# VAPOR CONSERVATION



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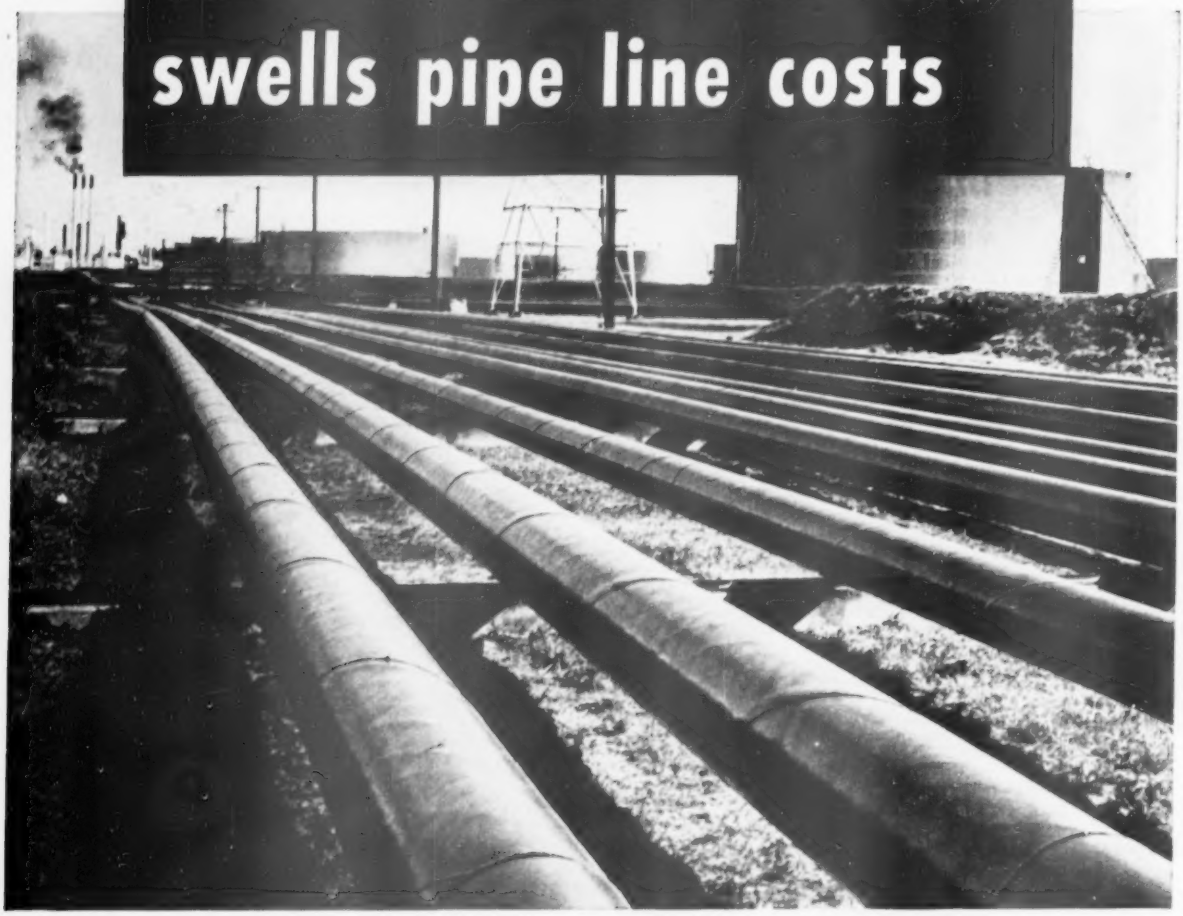

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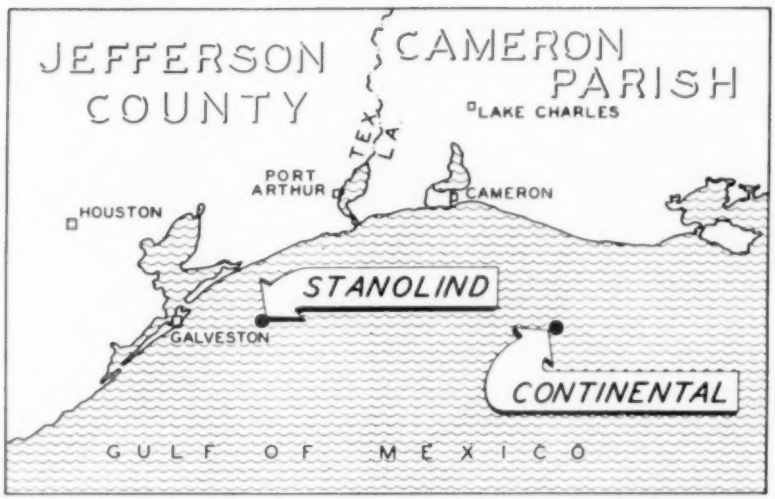



# Shelf Drillers Poised

## Stanolind or four-company operation expected to spud first well in government-controlled offshore land within 2 weeks

**William P. Sterne**

HOUSTON. — The question of who will drill the first wildcat in the government - controlled Continental Shelf since Congress passed the Submerged Lands Act should be answered within the next 2 weeks. Two wells are almost ready to spud in.

A deep wildcat test on the outer Continental Shelf off Louisiana is scheduled to be started within 2 weeks by a group of operators. Participating in the venture are Continental Oil Co., Cities Service Oil Co., Atlantic Refining Co., and Tide Water Associated Oil Co.

At the same time, Stanolind Oil & Gas Co. reports its first drilling venture on the shelf will get under way off Galveston Island around May 1.

Stanolind received the first drilling permit from the Interior Department to drill on the shelf, but may be nosed out by the joint operation in spudding in the first wildcat.

**Far offshore . . .** The four - company wildcat will be located in Block 192, Louisiana State Lease 1,656, 30 miles from the nearest land and south of the town of Cameron, La., in Cameron Parish. Nearest production lies 25 miles north and a little west, where Superior Oil Co. drilled a gas well. An 8,600-ft. dry hole was drilled by Superior in 1949 about 10 miles northwest of the new location.

The Continental group's wildcat will be drilled to 13,000 ft. from a template-type platform standing in 60 ft. of water. The group has awarded the drilling contract to Nicklos Drilling Co., Houston, which is now building the rig. The contractor has chartered a barge from Gulf Oil Corp. and a tender ship is to be floated in to serve the drilling platform.

Each of the firms has a 25 per cent interest in the venture. The companies hold a block of 15,000 acres, which were acquired in 1947. The leases have been validated by the Govenment.

The Conoco group holds the second Interior Department permit issued since the Submerged Lands Act was signed by the President last May.

The joint venture is the first deep-water offshore operation off the Louisiana coast since the passage of the federal legislation. There is considerable offshore activity, but it is confined to the 3-mile limit controlled by Louisiana. Theoretically, the state's tidelands boundary ends at the 3-mile point. Texas has jurisdiction over its coastal area out to 10½ miles.

**Stanolind's plans . . .** Stanolind's drilling location is on State Tract L-141, Lease 31,592, about 25 miles due east of Galveston and 19 miles from the nearest land. The company has held leases on the land since 1947.

The company reported that its new 83 by 82-ft. template-type drilling platform is nearing completion and will be barged out to sea some time this week. The platform is being fabricated by Brown & Root, Inc., Houston.

Stanolind also plans to drill on government - controlled tidelands off the Louisiana coast at a spot straddling the Cameron - Vermilion Parish line about 10 miles from shore, but no details have been released on this operation.

**Second platform . . .** Stanolind's will be the second offshore drilling platform installed off the Texas coast since the tidelands controversy was settled. The first to go on location was that of Standard Oil Co. of Texas, off Mustang Island, Nueces County.

The Standard of Texas operation is within the 3-mile limit and is on state-controlled lands.

## Well Isn't a Well—Yet

HOUSTON.—There's an oil well in Harris County that's not an oil well—legally.

Jack W. Frazier, veteran wildcatter, was so anxious to drill this well he forgot to take out a permit from the Texas Railroad Commission.

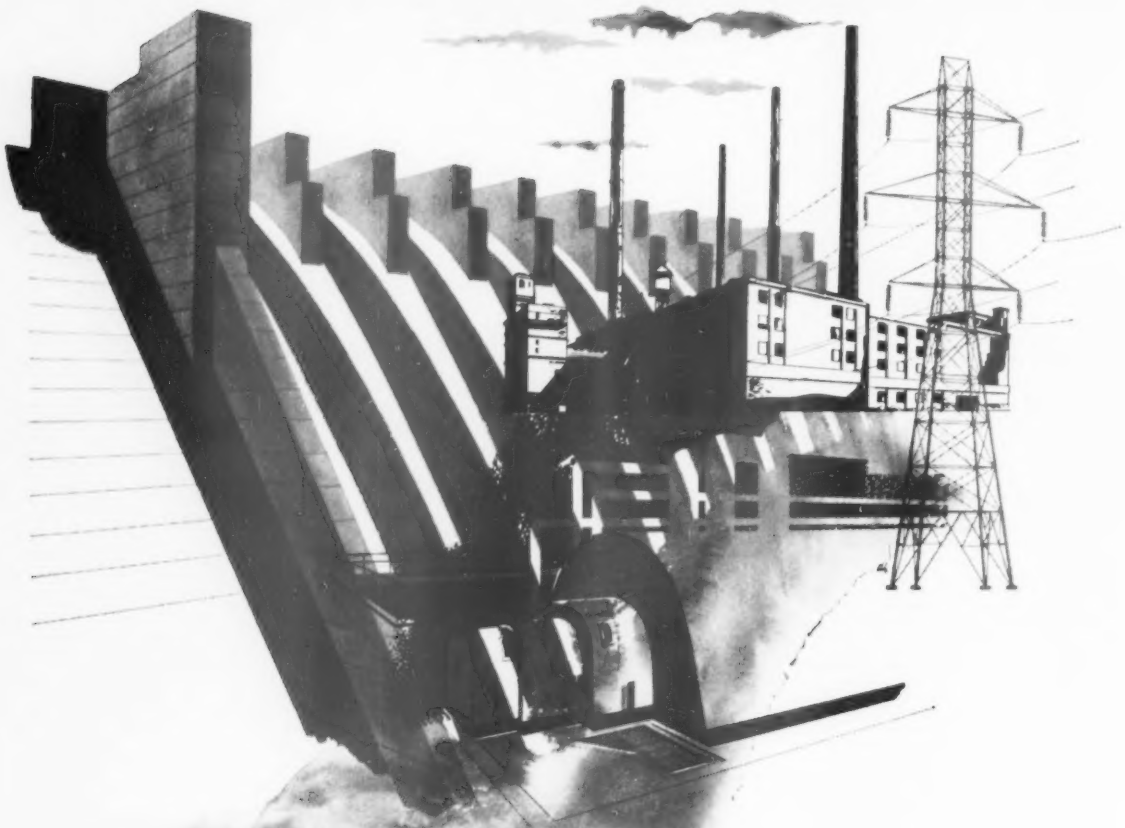
His A-2 Minnitex, a new oil discovery in Mykawa area of Harris County, is shut down until this "mistake" can be rectified. In fact, he can't even take a potential on the well (although there are reports it has about 130 ft. of oil sand) until the well is "drilled." Frazier is sitting it out until his hearing comes up on the 15th of this month for permission to drill it.

Frazier isn't worrying too much about this particular well, though. He's already staked locations for four more. All will be drilled to 6,500 ft.

He has also petitioned the Railroad Commission to classify the Mykawa and New Mykawa areas as a piercement-type salt dome. This will eliminate hearings before the "Rule 37 department." If the commission goes along, it will mean that Frazier and others can drill as many wells as they want in the area.

## Allowable Cut Planned

BATON ROUGE. — Conservation Commissioner John Hussey announced Louisiana's daily oil production allowable is scheduled to take a cut in May of 5 per cent to about 661,000 bbl. He said the cut will bring production in line with market demand.



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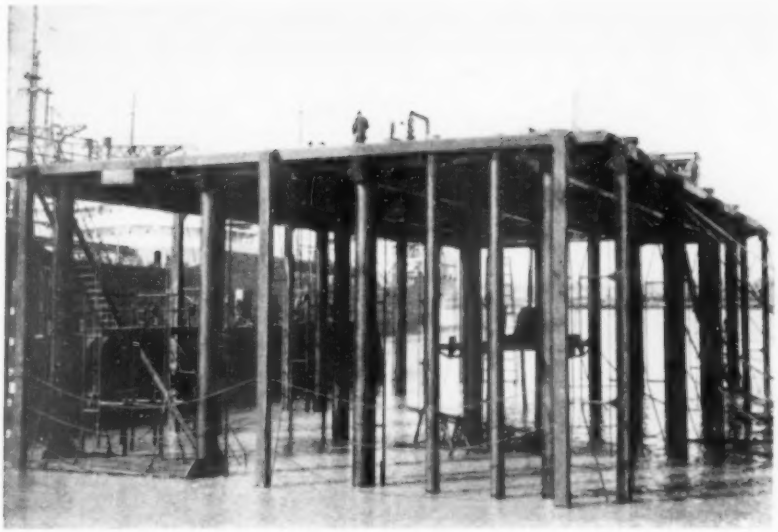

## New Calco Barge Rides . . .

# Elevator to Ocean Floor

NEW ORLEANS.—The first self-stabilizing elevated-deck drilling barge is now undergoing final outfitting here for The California Co., which will use it in protected waters along the Louisiana Gulf Coast.

Built to operate in up to 25 ft. of water, its design eliminates expensive shell matting necessary with conventional submersible drilling barges operating in shallow water.

The barge is being fitted with a diesel rotary rig and a conventional 140-ft. derrick. It is slated for use at Main Pass, where Calco also has a unique six-well drilling rig on a permanent-type platform *(The Oil and Gas Journal, January 18, pages 79-90)*. Water at Main Pass is 20 to 25 ft. deep.

**Hull goes down . . .** This is not the first barge designed for submerging the bottom hull. Ocean Drilling & Exploration Co. of New Orleans now has such a barge under final construction at Alexander Shipyards, Inc., here, but it works on an entirely different principal.

The new Calco barge is the first using hydraulically controlled stabilizers, or columns, on which the barge literally "crawls" up and down during raising and lowering operations. Its design is by Friede & Goldman, Inc., naval architects, and is similar to a big affair which the architects have drawn up for use in deeper waters.

To overcome the high center of gravity of Calco's new barge, self-stabilizing pontoons are incorporated in the unit.

To sink the barge, eight telescopic columns, fitted with four stabilizing pontoons, are pushed down through the water by hydraulic force until the pontoons are resting on the bottom of the ocean. When ballast tanks in the barge's lower hull have been flooded, the barge unit actually rides down these columns. Hydraulic fluid, bled from cylinders, inside the columns, controls the barge's rate of descent. Since the pontoons ride to the bottom with the columns, once the lower hull unit is resting on bottom, the barge is ready to drill.

In raising the barge, the lower hull literally pushes itself up on the eight steel columns by means of the hydraulic pressure. Once the unit has surfaced, water is pumped out of the hull and the eight columns are retracted into the barge.

**Odeco's barge . . .** Ocean Drilling & Exploration Co.'s barge appears similar, but the major difference is in the method of raising and lowering, and the fact that heavy components of drilling machinery are encased in the lower hull *(The Oil and Gas Journal, February 8, page 96)*. The center of gravity on Odeco's barge is low enough that no such retractable columns are needed. In raising and lowering operations, only ballasting is used.

American Tidelands, Inc., a new company, is building a barge similar to the Odeco barge, but it differs from both Calco's and Odeco's in principle of operation.

# ROCKY MOUNTAIN

## Indian Land Offered

### Cullen's offer to manage Blackfoot lands rejected

BILLINGS, Mont.—The Billings office of the Bureau of Indian Affairs will offer 120,000 acres of Blackfoot Indian Reservation lands in Montana for leasing.

The announcement of the lease offering by P. L. Flicklinger, manager of the Billings Indian Affairs office, is, in effect, a rejection of a proposal by Lucien Cullen, Houston, for private management of the resources of the reservation.

Cullen had proposed an agreement with the Blackfoot tribal council which would allow him to administer oil and gas, timber and other reservation resources. The staff of the Indian Affairs bureau decided such an agreement would not be valid without special legislation and such legislation would relieve the Government of all responsibility.

Spokesmen for the Blackfeet said the tribal council would not enter into an agrement with Cullen if Government responsibility were withdrawn.

Rocky Mountain oil operators became concerned several weeks ago when Cullen's proposal was made public and many objected to the possible change in the competitive leasing system.

Considerable interest in leases along the overthrust belt fronting the Montana Rockies has been evident in recent months. Substantial discoveries in similar areas of Canada have prompted renewed interest in the area. Much of the land available for lease on the Blackfoot Reservation lies in this section.

## New Wyoming Discovery

DENVER.—True & Brown and R. H. Fulton have a big new Newcastle discovery 4 miles west of previous Weston County, Wyoming, production.

The E-1 Western Empire-Government was completed for a flow of 800 bbl. of oil daily. The new pool is northwest of the axis of the producing trend in Clareton field, and is west of failures on the western edge of previous Newcastle production through the Black Thunder area of the field.

# SACROC Suit Filed

## Moncrief interests ask court to tie Railroad Commission hands in enforcement of huge water flood unit agreement

AUSTIN.—W. A. Moncrief and associates have filed suit in the 126th District Court here challenging the constitutionality of Texas Railroad Commission orders approving the SACROC Unit agreement and field rules for Kelly-Snyder field, Scurry County, West Texas.

The Moncrief group charges the commission refused to examine or pass on the fairness of the terms of the unit agreement and allowed the Scurry Area Canyon Reef Operators Committee to increase its share of the field production early in the primary life of the field. This was done, Moncrief contends, at the expense of the plaintiffs and others.

The commission orders of January 30, 1953, and January 18, 1954, were entered without any evidence that nonsigners were protected and without evidence as to how the unit and secondary-recovery program would actually operate, including costs and benefits of such a program, Moncrief contends.

**Moncrief complaints . . .** The adopted program, it is charged in the suit, is not patterned after accepted conservation practices and is dangerous in that several years may elapse before its effects become fully felt. The 73,000,000 bbl. or more of water injected per year into the producing formation, the Moncrief group contends, would cause irreparable damage to the field's best wells and leases, including those of the plaintiffs.

The Moncrief petition, which asks for a permanent injunction against commission enforcement of the SACROC unitization and field rules orders, argues that properties of the Moncrief group are in a particularly hazardous position. On the west and southwest flank of the gross reef mass in Kelly-Snyder field, it says, the percentage of porous reef and the effective permeabilities are lower than in the rest of the field and much lower than in that portion underlying the plaintiffs' properties on the east side of the field. Thus injected water, from input wells along the crest of the ridge in the Canyon reef formation, would travel more rapidly and in greater quantities eastward toward the plaintiffs' leases.

Compulsory and coercive unitization and secondary-recovery operations by waterflooding, the petition charges, is unauthorized in Texas and beyond the powers granted the Railroad Commission.

**State answer expected . . .** No hearing will be set on the petition for injunction until the state, which will act for the commission, files its answer.

The SACROC Unit takes in nearly 50,000 productive acres in Kelly-Snyder and is the world's biggest water-flood project from the standpoint of acreage. The project, in addition to the line-type flood plan, calls for gas injection in the northern end of the field.

The Moncrief group has objected strongly throughout the long struggle before the commission to the crestal water flood and to a proposal for a bonus allowable based on amount of water injected.

It has backed instead a plan for gas injection along the crest and water injection on the fringes of the field below the oil-water contact.

**Allowable transfer . . .** The Railroad Commission meanwhile is considering the SACROC proposal to transfer the allowables of 94 wells in the west-southwest portion and 9 more in the south-southeast part of the field to 62 better wells near the center of the field.

E. L. Anders, Jr., chief engineer of SACROC Unit, said the allowables transfer is being requested to minimize the pressure decline in the areas of the field where the 103 poorer wells are located, to reduce the over-all amount of reservoir voidage, and to allow more efficient use of reservoir energy and lessen waste.

All these wells, Anders said, have high gas-oil ratios and low bottom-hole pressures. The nine in the south-southeast portion of the field are producing large percentages of water, he said.

The application was opposed by the Moncrief group, which contended that SACROC is trying to perpetuate the allowables of the 103 inferior wells and to do so quickly "before declining productivity reduces any further the amounts which can be transferred."

# Eight Floods Okayed

## Commission approves West and North Texas projects

AUSTIN.—The Texas Railroad Commission has given eight water-flood projects in Texas the go-ahead and has received application for another.

Six of the approved projects are in North Texas, two in West Texas.

The North Texas floods were proposed by:

. . . **Cities Service Oil Co.** for the Milham sand at 2,290 ft. underlying its Waggoner "D" lease in Wilbarger County Regular field, Wilbarger County. One injection well.

. . . **Magnolia Petroleum Co.** for the 1,700-ft. sand under its Will George "A" and "B," Holtzen, Locheofner, Thom, Viles, and George "A" leases in Wichita County Regular field, Wichita County. Eleven injection wells.

. . . **Neff & Burchard** for the Fry sand at 255 ft. under its Chism lease in Shackelford County Regular field, Shackelford County. One injection well.

. . . **Woodson Oil Co. and Sheets & Walton Drilling Co.** for the Strawn sand at 2,555 ft. under their L. C. Atkinson "E," L. E. Parrott "F," and Spain Estate leases. Four injection wells.

. . . **Star Oil Co., Inc.,** for the Upper Conglomerate underlying Ritchie field, Montague County, at 5,600 ft. One injection well.

. . . **Bohner Oil Co.** for the Gunsite sand at 500 ft. under its H. O. Prideaux lease in Young County Regular field, Young County. Four injection wells.

The West Texas projects were proposed by:

. . . **Cities Service** for the Grand Falls formation at 2,430 ft. under its McDonald Unit lease in South Ward field, Ward County. Five injection wells.

. . . **Richardson Oils, Inc.,** for the Colby sand at 3,250 ft. underlying its W. E. Baird lease in Keystone Colby field, Winkler County. Five injection wells.

Approval of all projects included the commission's standard provisions for expanding injection facilities and for transforming allowables of injection wells.

American Republics Corp. asked the commission to approve its plans for flooding the Rosenberg sand underlying its Floyd Billings and Esmeralda leases in Billings field, Webb County, Southwest Texas.

## Deeper Pays Added

### West Texas drilling goes deep in old shallow areas

ODESSA, Tex.—Developments in West Texas last week added considerable reserves from the deeper formations, in or near old shallow production.

Latest in the big discoveries is Cities Service Oil Co. 1-K TXL, shown on the above map in the southwestern tip of the South Cowden (San Andres) field in Ector County. This well, which is surrounded by 4,000-footers, flowed 1,186 bbl. of oil a day on completion test from Ellenburger pay at 12,883-12,908 ft. On the basis of drill-stem tests, there was an effective 85-ft. pay section above the water. Cities Service has made location for a southwest offset, as the 1-E TXL.

Other majors holding acreage nearby include Continental Oil Co., Amerada Petroleum Corp., Gulf Oil Corp. and Stanolind Oil & Gas Co.

**Crockett County . . .** Pure Oil Co. 35 Vaughn, in a San Andres producing area 10 miles northwest of Ozona, had tested oil throughout a 208-ft. Ellenburger section at last report. The well had top of pay at 7,585 ft., flowing oil at 7,667 ft., and at 7,718 ft. the flow had increased to 142 bbl. in 3 hours. Operators planned to drill ahead when the last test, between 7,768-93 ft. recovered oil. The thick pay section and heavy oil flow indicate the possibility of another structure on the order of Elkhorn-Ellenburger field, 5 miles to the northwest.

Cities Service has also completed a Strawn discovery in northern Crockett County, west of World field, at its 1-C Shannon. Initial potential was 1,002 bbl. of oil a day through 32/64-in. choke from pay between 8,190-8,204 ft. This area came in for a little deep exploration last year, when two Strawn wells were drilled about 3 miles to the north of 1-C Shannon. Both were by Continental. The firm's 2-C Harris came in first, for 364 bbl. from Strawn pay at 8,075 ft., and the 1-D Harris, ½ mile east offset, flowed 651 bbl. of oil a day from pay between 8,190-8,238. The latter test was an Ellenburger exploration but found sulfur water in that formation.

## Gas Tax Passes

### Producers to pay new rate of 9 per cent on Sept. 1

AUSTIN.—Texas gas producers effective September 1 will start paying a state severance or production tax of 9 per cent of market value—a jump in the rate of about 36.5 per cent over the present levy of 5.72 per cent.

The tax boost was wrapped up by the legislature and sent to Gov. Allan Shivers for signature when the house accepted senate amendments to the bill.

The new tax law provides that the 9 per cent tax will remain in effect until September 1, 1955. The rate will then be cut to 8 per cent for 1 year, and then to 7 per cent beginning September 1, 1956.

The law exempts from the tax gas: (1) injected below ground unless sold for that purpose, (2) produced with oil and lawfully vented or flared, (3) used for lifting oil unless sold for that purpose.

All condensate recovered from the gas will be taxed at the same rate as oil (4.6 per cent of market value) and valued, for computing the tax, at the prevailing market price in the general area where it is recovered. Condensate, as provided in the law, includes those liquid hydrocarbons which are or can be recovered by means of a separator. It does not include those recovered by means of refrigeration or absorption and separated by a fractionating process.

All natural-gas liquids recovered will be taxed at the same rate as gas.

The law also fixes a tax of 2.42 per cent on gross receipts for oil-well servicing. It covers such work as: (1) cementing the casing seat of any oil or gas well, (2) shooting, fracturing, or acidizing, and (3) surveying or testing formations when instruments or equipment used, or any portion of them, is located within the well bore.

**Minimum price out . . .** The senate state affairs committee in effect killed the house-passed Hinson bill which would have enacted a token tax on the dedication of gas reserves.

The bill, which was intended to provide another test of the constitutionality of a tax on gas going into the so-called long lines, was sent to a subcommittee with just a few days left to go in the session.

Another house-passed bill affecting gas fared better. This was HB 64 which provides that gas companies or producers may sell gas for agricultural purposes to farmers without being subject to regulation as a gas utility.

The senate adopted an amendment, however, which provides that the exemption applies only when the gas is sold exclusively as fuel for water pumps.

## Allowable Cut

### High crude stocks force Texas to trim May figure

AUSTIN.—The Texas Railroad Commission last week set the state's May allowable at 2,903,341 bbl. daily, a cut of 181,973 bbl. compared with the allowable in effect on April 3.

High stocks of crude were blamed for the cut. Commission Chairman Ernest O. Thompson pointed out that crude-oil stocks on April 3 stood at 268,547,000 bbl., the result of a 4-week increase of 6,613,000 bbl. Of this amount, Texas alone was responsible for 5,446,000 bbl. of the gain. The Oil and Gas Journal this week forecasts an increase of about 8,000,000 bbl. during the month of April *(See page 274).*

The May cut was accomplished by setting a 17-day producing scheduled for the month, compared with 18 days in both March and April.

Most companies had asked for a 17-day schedule, but Gulf Oil Corp. and Sinclair Refining Co. asked for 18 days and Sun Oil Co. asked for 19 days.

### Price Suit Reversed

AUSTIN.—Texas' 5-year-old "conspiracy" charge against 10 major companies marketing in the state may start through the courts again soon.

The Third Court of Civil Appeals last week reversed a district court ruling favoring the companies and held the state has cause to sue them.

The suit charged that the companies conspired to maintain tank-wagon gasoline prices to "eliminate competition between themselves." It was filed following a price increase announced by all companies in July 1949.

The companies involved are Arkansas Fuel Oil Co., Cities Service Oil Co., Continental Oil Co., Gulf Oil Corp., Humble Oil & Refining Co., Magnolia Petroleum Co., Standard Oil Co. of Texas, The Texas Co., Sinclair Refining Co., and Phillips Petroleum Co.

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# Iranian Talks Begin

## International group representatives begin delicate job of selling their program for Iranian oil to government

**Dahl M. Duff**

NEGOTIATIONS aimed at resuming large-scale production of oil in Iran were started last week in Teheran by officials representing a newly formed international oil consortium and the Iranian Government.

The consortium's 22-man negotiating team is headed by Orville Harden, retired vice president of Standard Oil Co. (N. J.) and a leading American expert on foreign oil. Harden is assisted by H. E. Snow, a managing director of Anglo-Iranian Oil Co., Ltd., and J. H. Loudon, a managing director of Anglo-Saxon Petroleum Co., Ltd. (Royal Dutch-Shell).

The principal Iranian negotiator is Ali Amini, finance minister. Among the advisers to the Iranian Government is Torkild Rieber, president of Barber Oil Co. and one-time board chairman of The Texas Co., who arrived in Teheran April 6. Dr. Reza Fallah, who has managed the Anglo-Iranian properties in southern Iran since the 1951 nationalization, also is expected to take part.

**No predictions . . .** There were no predictions on either side as to how long the negotiations might last. On his arrival in Teheran, Harden said that it was difficult to make such an estimate. He added, "we are optimistic," in a reference to the eventual outcome. The meetings, which got under way April 14, are being held at the White Palace, the prime minister's official residence, and at the historic Gulistan Palace.

Herbert Hoover, Jr., special Iranian oil adviser to the U. S. State Department, is in Teheran but is expected to remain in the background, at least so long as the talks make reasonable progress. Six months of patient groundwork by Hoover in Teheran, London, and Washington led up to the present negotiations. Another government official in Teheran is Angus Beckett, former British petroleum attache in Washington and now assistant secretary of the Ministry of Fuel and Power in London. He is acting as technical adviser to the British ambassador in Teheran.

**Proposals still secret . . .** The final formation of the eight-company consortium and the dispatch of the negotiating team to London was announced April 10 in London, but no definite information was disclosed on the nature of the proposals the group had agreed to present to Iran.

The broad outlines of the settlement plan are understood to be as follows:

The consortium will undertake to provide working capital, necessary technical personnel, and equipment to resume producing and refining operations in progressively stepped-up volume. Some reports have mentioned a 300,000 bbl. daily crude output and 150,000 bbl. daily refinery throughput at the end of a year's time, but the exact level to be guaranteed presumably is one of the points under negotiation.

The same group of companies also will provide market outlets for Iranian crude and products in the same proportion as their share holdings in the consortium—8 per cent for each of the five American companies, 40 per cent for Anglo-Iranian, 6 per cent for Cie. Francaise des Petroles, and 14 per cent for Royal Dutch-Shell. It is believed the Iranian Government might seek to hold back a small share of the production to sell itself, plus a sufficient supply for the domestic market.

**Control important . . .** The consortium also was expected to insist on some measure of control over the actual operations. It has been reiterated time and again that the companies involved could not be expected to make the heavy investments in the undertaking unless they had assurances of efficient, nonpolitical management. It was believed the consortium would ask a 25-year lease to operate the properties in the name of the National Iranian Oil Co.

The requirements for compensation may also prove to be extremely difficult to settle. Anglo-Iranian has asked additional payment for loss of future profits from the concession, and the Iran Government has a number of counterclaims against the company. There is a possibility that some of the compensation questions may be referred to an impartial outside agency such as the World Court for final determination.

The division of revenue in all probability will be along the lines of the 50-50 deals in effect in other major oil-producing countries. The companies making up the consortium will certainly agree to nothing that could be interpreted as placing a premium on expro-

**Shell Wildcatting 6,000 Sq. Miles in Tunisia**

**Oil exploration work has been under way for the last several years in Tunisia. This is a recently started wildcat test, a Shell well at Rouissate about 43 miles west of Sousse. The operating company is Cie. des Petroles de Tunisie (C.P.D.T.) in which Royal Dutch-Shell holds 65 per cent interest. The company has an exploration permit over nearly 6,000 sq. miles (a Shell photo).**

## Work Started on Iraq Government Refinery

**Preliminary site work is under way on the Iraq Government's new 24,000-bbl. daily capacity refinery at Dora, near Baghdad. The plant is being built by M. W. Kellogg Co. and is scheduled to begin operation the middle of next year. Facilities include the main crude unit, power house, treating plants, and a can manufacturing plant. Crude oil will be supplied by Iraq Petroleum Co., Ltd., under its 1951 concession revision agreement which provides that Iraq will pay a token price of slightly more than 10 cents a barrel. A 12-in. line is now being laid from I.P.C.'s Station K-2 at Baija to Baghdad, and when the refinery is in operation, the government will pay the annual Baija-Baghdad pumping costs. Production from the new refinery will meet the country's internal needs.**

priation. Iran would have to meet whatever compensation payments are agreed on out of its own share. The revenue to the consortium members and to Iran would be figured after operating expenses are deducted, as in the case with other 50-50 agreements in the Middle East.

The oil-company officials now negotiating with the Iranian officials have just completed several months of discussions between themselves in London on problems connected with formation of the consortium and the proposals to be made in Teheran. Dozens of specialists representing the eight companies in such fields as law, economics, operations, etc., participated in these meetings.

**British divulge little . . .** The British Government made known the organization of the consortium in a message to the Iranian Government. The consortium itself made no announcement. Anthony Eden, British foreign secretary, told the House of Commons that the British Government "welcomes this development."

Eden confirmed that each of the participating companies would pay Anglo-Iranian for the privilege of "buying in" the group. The cost of the shares was not disclosed, since the figure agreed on depends on the terms of the final settlement with Iran.

The British Foreign Secretary said that "it would be wrong to discuss now just how the other companies buying in will affect Anglo-Iranian's claim for compensation against Iran. . . ." He declined to comment on the degree of management control to be sought by the consortium. Further, in reply to a question, he denied that the British Government had agreed to give up its interest in Anglo-Iranian which amounts to about 52 per cent.

## Suez Canal Cuts Toll

A reduction in Suez Canal tolls effective July 15 has been ordered by directors of the Suez Canal Co. meeting in Paris. The lower rate is for a period of a year, after which rates will be reexamined in light of costs at that time.

For petroleum, the reduction is equivalent to about 1 cent off the present 11-12 cent rate per barrel. The actual new rate set was 34 Egyptian piasters per Suez net ton for loaded vessels, and 15.5 piasters for vessels in ballast. Tankers carrying oil make up more than 60 per cent of the tonnage of vessels using the canal, and last year, petroleum movement in both directions averaged around 1,120,000 bbl. daily.

# Wafra Reserve Set

### Pacific Western says field has billion bbl. in place

THE total amount of Burgan sand crude oil in place in Wafra field in the Kuwait-Saudi Arabia Neutral Zone is estimated to be on the order of a billion barrels.

This was disclosed in the recently issued annual report of Pacific Western Oil Corp. which has a half interest in the operation. The Pacific Western report added that recoverable reserves of this oil are estimated at 429,000,000 bbl. by the company's geologist at the field.

Wafra field was discovered April 13, 1953, and commercial production began in January. American Independent Oil Co., the other concession holder, is operator.

Pacific Western said the agreement reached by the company regarding the pipeline and terminal facilities built by Aminoil provided for their use by Pacific Western on an equal basis with Aminoil on a throughput charge, plus one-half the operating and maintenance costs. A 10-in. line from the field to a terminal on the Neutral Zone coast will be built by Pacific Western as soon as practicable.

The report said a test of the shallower producing zones at Wafra is being made and has already proved that oil is to be found below the first anhydrite. This oil is of 16° gravity and reserves may or may not be very large, it said. Additional zones remain to be tested.

## Hamburg Plant Ups Capacity

New distillation equipment which will provide a major increase in capacity of the Hamburg refinery of B.P. Benzin-und Petroleum, G.m.b.H., is expected to be placed in operation in the near future.

Present capacity of the plant is 17,000 bbl. daily. The new Foster Wheeler combination unit will provide 12,000 bbl. daily capacity in atmospheric distillation and 7,000 bbl. daily in vacuum distillation.

Other important improvements to the refinery of this German affiliate of Anglo-Iranian Oil Co., Ltd., are under construction. A 6,000-bbl. Platforming unit, the first of its kind in continental Europe, is scheduled for completion in early 1955.

The company also is constructing a continuous asphalt blowing plant as well as mixing and filling facilities for production of 50,000 tons of asphalt annually. The refinery railway system

has been doubled, a new jetty for asphalt and fuel oil is under construction, and five new 88,200-bbl. crude oil tanks are being erected.

The refinery now has 5,500 bbl. daily capacity in thermal cracking, and 3,000 bbl. daily in thermal reforming, in combination with one of the two crude units. Another 2,500 bbl. daily in thermal cracking will be provided early next year following conversion of the present reformer.

# New Australian Plans

## Tulsa consultant leaves to stake wildcat location, two rigs to follow; other exploration activity developing

PLANS for spudding a wildcat in the Maryborough basin in Queensland, Australia, were announced last week by Gene Goff, president of Lucky Strike Drilling Co., Tulsa.

J. M. Wanenmacher, of the consulting firm of Keplinger & Wanenmacher, Tulsa, left for Australia last week to study Lucky Strike's 3,648,000-acre concession and stake a location for the first test on it.

Goff said his company is receiving bids on two 12,000-ft. rigs and is expected to purchase them this week. These are being bought for Oil Drilling & Exploration, Ltd., a contract drilling firm in Australia in which Lucky Strike owns a 20 per cent interest. One of the rigs will be used by Oil Drilling for the Lucky Strike concession wildcat and the other will be made available for contract work.

Lucky Strike's interest in the contract-drilling firm was acquired by granting Oil Drilling an undivided 20 per cent interest in the Lucky Strike concession.

**July date set . . .** Goff said it is hoped that the two new rigs can be shipped within 3 weeks and that the Maryborough basin test can be spudded in during July.

Goff, an active independent in Oklahoma, Arkansas, Texas, and Nebraska, is board chairman of the newly organized Oil Drilling & Exploration. Goff also is president of Goff-Leeper Drilling Co., of Tulsa and Ardmore, and executive vice president of Pete Street Drilling Co., Tulsa. Directors of the new Australian drilling firm are Julius Kruttschnitt, Brisbane mining executive and stockman; J. M. Greenwood, Sydney accountant and attorney; and John G. Antliff, Sydney, who will also serve as general manager.

In other developments in Australia last week it was disclosed that:

**. . . Another contract-drilling** company, Petroleum Drilling Corp., has been formed. Santa Fe Drilling Co., of Santa Fe Springs, Calif., is the controlling company.

**. . . A 7,500-ft. rig** is being bought by Associated Freney Oilfields for use on leases formerly held by Freney Kimberley in the Fitzroy basin of western Australia.

**. . . Geological parties** have been put in the field by Frome Broken Hill, Pty., Ltd., which is owned by Anglo-Iranian Oil Co., Ltd., Standard Vacuum Oil Co., and Zinc Corp. The company may undertake a seismic survey.

There is much interest in what the Australian Government may do regarding the unexplored concessions of West Australian Petroleum, Pty., Ltd.

WAPET has amply fulfilled its concession obligations in the area of its Exmouth Gulf discovery, Australia's first commercial producer, but it has done little in its other concession areas. These cover virtually the entire west coast. The permits expire in October.

In Australia, initial concessions granted cover a minimum of 1,000 sq. miles. At the end of a given period, during which certain expenditures must be made, a "license to prospect" is issued. This covers an area of not less than 8 nor more than 200 sq. miles. Having satisfied government requirements during this stage, a "lease" of not less than 4 nor more than 100 sq. miles is granted. Any of the permits may be extended at the discretion of the minister of mines.

Among Australians interested in oil, discussions center around the question of whether the government, in view of WAPET'S wildcat success on the west coast and its large expenditures to date, will extend any of the permits, some of them, or all of them.

## Kuwait Tops Million Barrels

For the first time in the history of oil operations in the Middle East, production from an individual country has passed the million barrel daily mark.

Kuwait Oil Co., Ltd., owned 50-50 by Anglo-Iranian Oil Co., Ltd., and Gulf Oil Corp., is reported to have reached an output in March averaging 1,012,000 bbl. daily. This compares with a reported production of 820,000 bbl. daily in February and a previous record last October of 950,300 bbl. daily.

Kuwait now ranks as the world's fourth largest oil producing country, ranking after the United States, Venezuela, and Russia. Last year, it passed Saudi Arabia to become No. 1 in the Middle East.

Saudi Arabian production also hit a record in March, averaging 978,300 bbl. daily, against 940,900 bbl. daily in February, the previous record for this country.

These two countries, along with Iraq, for the last 2 years, have been producing additional oil to supply markets that formerly were met by Iranian production.

## Burma Company Registered

The new, partially government-owned company which will take over the producing and refining industry in Burma has been registered in Rangoon as a private company.

It is Burma Oil Co. (1954), Ltd. The agreement on its organization was signed January 12 as the culmination of negotiations held intermittently over a period of several years by the Burmah Oil Co., Ltd., Indo-Burma Petroleum Co., Ltd., British Burmah Petroleum Co., and the Burmese Government.

The new company will have an issued capital of 200,000,000 kyats, or about $42,000,000, divided into 2,000,000 shares of 100 kyats each. Two-thirds of the shares will be issued to the oil companies as payment for assets transferred, while the Burmese Government will hold the other third of the shares.

## New Tanker Freight Scale

The Tanker Brokers Panel in London has assessed the weighted average of world tanker freights at the equivalent of U.S.M.C. minus 20½ per cent. Actual assessment was given as 14.4 per cent above the London Market Tanker Nominal Freight Scale which was set in late 1952 to replace the old Ministry of Transport rates.

Determination of the new tanker freight indicator was asked by the Shell organization following the decision of Shell and Anglo-Iranian Oil Co., Ltd., to discontinue use of the 2-year time-charter rate assessment which the London Panel formerly provided semiannually for the two oil companies.

Under the new plan, the London Panel will calculate the weighted average of charter rates for all tankers in the world-wide trade. This will include long and short-term time charters as well as spot voyage charters, excluding only certain special trades.

## Chinese Producer

### Taiwan oil search yields 60-bbl. daily discovery

THE Chinese Nationalist Government is proving up a new productive area on the Chutauchi structure in the south part of Taiwan (Formosa).

According to Leo W. Stach, petroleum consultant in Japan, the Chinese Nationalists can make claims rivaling those of the Chinese Reds behind the Bamboo Curtain in Northwest China.

In spite of limited resources, the government-owned Chinese Petroleum Corp., with the encouragement of the F.O.A. Mutual Security mission, has conducted an active exploration program in the past 2 years.

The first well to test a new area was drilled early in 1953 on a higher culmination on the same structural trend as the Chutung (Chikuto) gas field. The well ran into a steep flank on the structure just before the expected depth of the target horizon was reached. Operations have been suspended pending restudy.

**Second well producing . . .** The second well, at Chutauchi (Chikutozaki), was successful in finding production at about 2,600 ft. at a location structurally much higher than the insignificant production formerly developed by the Japanese low down on the southern plunge. After producing about 50 bbl. daily of light crude during swabbing the well began flowing intermittently in early February at the rate of about 30 bbl. daily, and is now pumping better than 60 bbl. daily of light paraffin-base crude (38.9° A.P.I.) with a gasoline content of 35 per cent.

The reservoir is apparently a fractured sandy mudstone about 50 ft. thick which appears to be above the objective horizon, so that deeper zones may also exist.

Although the production is small by most standards, it is important locally when it is considered that prior to this discovery the total average daily production of crude for all Taiwan since the war has been only about 50 bbl. More than 90 per cent of this production comes from the old Chuhuangkeng (Shukkoko) field in central Tiawan, where about 25 wells are still being produced.

Although the successful Chutuachi extension well is located about 1 mile north of the old producing area it is still far from the structurally highest part of this long narrow longitudinally faulted anticline, which has a total length of about 25 kilometers (15½ miles). The rugged terrain will present some difficulties in developing this large new potentially productive area, but it is likely that a significant contribution will be made to the local economy by reducing crude oil imports on which the Chinenes National Government is now almost entirely dependent.

**RUGGED TERRAIN of Central Taiwan (Formosa) presents drilling problems in the island's most potentially productive area.**

## Turks' Rules Awaited

### Exploration programs hinge on new oil law regulations

WHAT companies will enter Turkey with full-fledged oil exploration programs will become clearer after the regulations to the recently passed law are promulgated sometime this summer.

The regulations will spell out in more detail the various requirements and other conditions imposed by the law. Reports are that several Turkish officials will work on the regulations with Max Ball, Washington consultant, who assisted in preparation of the original legislation.

The law was enacted by a vote of 266 to 17 on March 7 and became effective March 16 when it was published in the official gazette in Ankara. It specifies that the regulations will be prepared within a period of 4 months and this will be up July 16.

**Study period . . .** A further period will be necessary to allow study of the regulations before applications for concessions are accepted. Thus it may be late summer or early fall before the filing period is opened. It is understood there will be no bidding for initial concession areas and that the government's oil department will arbitrarily decide overlaps in different applications.

The latter part of March the government began receiving applications for nonexclusive exploratory permits under the law. These will allow the companies to continue field work which the government authorized last year in advance of the law's passage. Among the companies reported to be interested in Turkey, some of which have done field geological work, are: Jersey Standard, Shell, Sinclair, Socony-Vacuum, Richfield, Gulf, Cities Service, Conorada, and Canada Southern.

### French Oil Search Continues

About 60 rigs are now being operated in the continuing intensive search for important oil production in France and its overseas territories, Dr. D. Trumpy, French geologist, told a recent petroleum geology meeting in Hanover.

Altogether, more than 1,000 deep wells have been drilled throughout the French Union, according to Dr. Trumpy. The program has been concentrated in the foothills of the Pyrenees, but since 1950, increasing attention has been given to the Paris basin.

## World Briefs

**The Berre l'Etang refinery in France** of Cie. de Raffinage Shell-Berre recently commenced operations in a unit recovering sulfur from catalytic-cracking plant gases. Production of pure elemental sulfur is placed at 4,000-5,000 tons in 1954. Its sale will be handled by Cie. de Saint Gobain.

**Pechelbronn, S. A. d'Exploitations** Minieres has concluded a contract for the processing of 150,000 tons (about 1,100,000 bbl.) of crude oil from Soviet Russia. The French company operates a refinery of 1,600 bbl. daily capacity at Merkwiller. The plant formerly charged principally crude from the small Pechelbronn field which is gradually becoming exhausted. The Soviet crude oil will be delivered under terms of the recent French-Russian trade agreement.

**Cia. de Petroleo Ganso Azul will undertake** a 5,000-ft. depth well on the Santa Clara concession in eastern Peru of the Canadian company, Peruvian Oil & Minerals, under an agreement recently negotiated between the two companies. The Santa Clara concession is about 150 miles north of Ganso Azul's field on the Ucayali River. Ganso Azul, controlled by Texas Gulf Producing Co., will drill the Peruvian O. & M. well after completion of five additional wells in Ganzo Azul field, expected some time this summer.

# Winners at Williston

**BIG PUSH FOR NEW OIL** is supplied by a pair of "Big Red" TD-24s, leveling drilling site for a new Amerada well in the Williston Basin, near Tioga, N.D.

## *Contractor Ward Mendenhall's four Big Red TD-24s keep jobs moving faster in the booming Williston Basin*

*"These big* INTERNATIONALS *are the tractors the drillers call on when the tough jobs come up,"* says Operator B. H. Adkinson, working in the booming Williston Basin in North Dakota. *"They can shove any load with all that power they have."*

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## Mud Expert

### Rogers uses leisure for writing, association work

WALTER F. ROGERS is a man without hobbies. It isn't so much that his job as chief chemist in the chemical unit of Gulf Oil Corp.'s Houston production division keeps him so busy; it's the outside interests that preclude almost all leisure-type activities except reading.

Rogers has just completed a term as president of the National Association of Corrosion Engineers. He also is active in the American Petroleum Institute. In fact, he was dubbed "Mr. Mud" by the A.P.I.'s southwestern district study committee on drilling fluids last year because of his extensive work with the group.

His writings on technical subjects are extensive and date back to 1942, when he presented his first paper before the American Institute of Mining and Metallurgical Engineers. His latest publication, the second edition of "Composition and Properties of Oil Well Drilling Fluids," is just off the presses. Most of his papers have been devoted to corrosion of production and pipeline equipment.

Rogers has been in Houston since 1927, when he moved there to work for Gulf Production Co. under a fellowship from Mellon Institute. His work then dealt primarily with oil-well corrosion problems.

Rogers had joined Gulf in 1926 immediately after receiving a degree from the University of Pittsburgh in chemical engineering. He received his degree of chemical engineer from the same university in 1934.

Besides the N.A.C.E. and the A.P.I., Rogers is a member of the American Chemical Society and the Houston Chamber of Commerce.

**Charles D. Vertrees** has been promoted by Continental Oil Co. from division geologist at Midland, Tex., to the newly created position of regional research geologist for the Southwest region at Midland. Vertrees joined Conoco as a land man at San Angelo, Tex., in 1925. He was promoted to district geologist at San Angelo in 1929 later transferred to Midland, and was named division geologist there in 1950.

H. F. SINCLAIR

**Harry F. Sinclair,** founder of Sinclair Oil Corp. and a member of its board of directors since the company's formation in 1916, will retire from the board with the expiration of his present term of office May 19. **William Gage Brady, Jr.,** New York investment banker, will succeed Sinclair on the board. Sinclair retired as president in January 1949, but continued as a director and honorary chairman of the board.

**Alex G. A. Piercey,** formerly chief chemical engineer for Madison Natural Gas Co., Ltd., at Turner Valley, Alta., has joined Royalite Products, Ltd., as process superintendent at Kamloops, B. C.

**Hubert van Drimmelen,** who has been with the Royal Dutch-Shell organization since 1929, has been made manager of Deutsche Shell, A.G., in Germany, succeeding **Albert de Graan.** Van Drimmelen has been connected with Shell's refining and shipping activities in Curacao.

**Thomas R. Shugart,** formerly a geophysical consultant in Dallas, has been named president of Research, Inc., a Dallas geophysical and geochemical firm. Before opening his consulting office, Shugart was president of Texana Exploration Co. and an executive of Geotechnical Corp. **R. Maurice Tripp,** vice president of Research, Inc., has resigned to open consulting offices. Tripp will continue, however, to work closely with Research, Inc.

**Peter F. Chapman,** reservoir engineer with Shell Oil Co., has been transferred from Wichita Falls, Tex., to Houston.

**Arthur L. Duff, Jr.,** Albuquerque, N. M., operator, has been elected to the board of directors of Reiter-Foster Oil Corp., New York.

**C. H. M. Burnham,** until recently vice president in charge of engineering for Panhandle Eastern Pipe Line Co., has opened consulting engineering offices in Merriam, Kans. He joined Panhandle in 1937 and was made vice president in 1943.

**Sidney H. Gottlieb,** for the past 2 years an independent consultant in Dallas specializing in evaluation of secondary-recovery projects, has joined Bradley, Oliver & Associates, Dallas petroleum consulting firm, as an associate. Prior to becoming consultant, Gottlieb worked for Placid Oil Co. in East Texas and Louisiana.

**C. E. Brandon** has been promoted by British-American Oil Producing Co. from foreman of Grass Creek field near Thermopolis, Wyo., to field superintendent in the Denver-Julesburg basin with offices in Sterling, Colo.

**H. H. Anderson** will complete his special services as vice president and general manager of Trans Mountain Oil

H. H. ANDERSON

A. F. TERRILL

Pipe Line Co. April 30 and will be succeeded by **A. F. Terrill.** Anderson, who retired in July 1952 after more than 35 years with Shell Oil Co. in the United States and Mexico, was employed temporarily by Trans Mountain to select, train, and manage an all-Canadian staff to operate the pipeline system. He also was a member of the firm's construction committee. Terrill joined Trans Mountain as senior aide to Anderson following his retirement after 32 years with Shell Pipe Line Corp. As assistant general manager he directed the hydraulic testing of the new pipeline and was in charge of the operating department.

# PERSONALS

**J. D. McConnell,** general manager of crude lines for Sinclair Pipe Line Co., has been elected to the board of directors of Goodall Pipe Line Co.

H. M. JOINER

**Howard M. Joiner** has been appointed to the new post of chief engineer of Peoples Natural Gas Co., Pittsburgh. **A. F. Kraus,** formerly superintendent of gas - measurement engineering, and **William F. Spencer,** formerly assistant chief mechanical engineer, also have been promoted to assistant chief engineers. Consolidation of all the firm's engineering activities is part of a reorganizational change to go into effect May 1. Joiner, formerly assistant superintendent of distribution and chief mechanical engineer, will supervise all company engineering functions.

**E. M. McGuire,** district engineer for Cities Service Oil Co., has been transferred from Bartlesville to Ponca City, Okla.

**J. W. Coffman** has been named administrative assistant of The Texas Co.'s West Texas division producing department, with headquarters in Fort Worth. Coffman joined Texaco in 1936.

**R. J. Swirczynski** has resigned as district geologist with Sohio Petroleum Co. in Casper, Wyo., to become Rocky Mountains division geologist for Houston Oil Co. of Texas. He will remain in Casper and replaces **W. G. Olson,** who recently resigned to become a consultant.

**Harrington A. Rose,** gas engineer for Stone & Webster Service Corp., has been named secretary of the general management section of the American Gas Association. **Bruce A. McCandless** has been acting secretary, but now will devote full time to his administrative duties as assistant to the managing director.

**Karl T. Feldman,** formerly chief engineer, has been elected a director of Sinclair Pipe Line Co. and designated director of engineering in an effort to complete reorganization of the engineering departments. He will direct and coordinate work of the electrical engineering department under supervision of **Glenn L. Ladd** and the general engineering department under supervision of **Paul D. Fell,** who has succeeded Feldman as chief engineer of that department.

**Darrell W. Matthews,** division petroleum engineer at San Antonio, Tex., for Continental Oil Co., has been transferred to Ardmore as assistant district superintendent for southern Oklahoma.

**W. E. McKittrick,** area geologist for Shell Oil Co. at Los Angeles, has been transferred to the company's head office in New York City. **J. M. Fouts, Jr.,** formerly area producing geologist, has succeeded McKittrick in Los Angeles. Other recent changes in the area exploration department include **R. L. Blocher,** promoted to district geologist at Seattle, Wash.; and **W. G. Freitag** and **H. H. Nuttli,** geologists, transferred from Vernal, Utah, to the Ventura district.

**Michael L. McGannon** has been promoted by Humble Pipe Line Co. from superintendent of the firm's Longview, Tex., district to assistant division superintendent at Longview. **Edgar R. Neath,** superintendent of the Mexia, Tex., district, has been named Longview district superintendent, succeeding McGannon, and **A. M. Brock** has been moved up from assistant superintendent in the Refugio, Tex., district to replace Neath as superintendent at Mexia.

J. M. CURRAN

**James M. Curran** has been named manager of the production and exploration department of Eastern States Petroleum Co., Inc., Houston. Curran formerly served in the production department of Tide Water Associated Oil Co. for 8 years, beginning in 1935, and prior to joining Eastern States in November 1951 was a geologist for Indiola Oil Co. of Houston. He has been chief geologist in the production department since joining Eastern States. **Harry Leyendecker** has resigned as vice president of the production department to become an independent oil operator. Leyendecker had been associated with Eastern States as vice president of the crude-oil-supply department and was appointed vice president of the production department in 1951.

**George J. Sonleiter** has retired as manager of United Gas Pipe Line Co.'s Shreveport district. He joined the firm in 1930.

**R. W. Edmund,** staff geologist for Sohio Petroleum Co. since 1953, has been promoted to assistant to the general manager of exploration.

**C. G. Bailey,** formerly division geologist at Midland for Texas Pacific Coal & Oil Co., has been transferred to the company's Fort Worth headquarters as staff geologist. He has been replaced at Midland by **Nolan Hirsch,** formerly with Deep Rock Oil Corp. at Midland.

**Millard K. Neptune,** president of Platte Pipe Line Co., Kansas City, will resign July 1 to become president of

M. K. NEPTUNE

RALPH MOORE

Egyptian American Oil Co. with headquarters in Egypt. **Ralph Moore,** vice president of Platte, will succeed Neptune as president. Neptune left Phillips Petroleum Co. in 1948 to become manager of Continental Oil Co.'s foreign department. In June 1951, he became president of Platte. During World War II and the Korean war, he served in the Petroleum Administration for Defense as assistant director of production. Moore was with Sinclair companies 22 years before joining Platte when it was organized in 1950. At present he is at Harvard University participating in the advanced management program. Egyptian American Oil Co. is a wholly owned subsidiary of Continental Oil Co., which is operator of a 75,000-sq.-mile oil concession recently granted by the Egyptian Government to Continental, Ohio Oil Co., Cities Service Oil Co., and Richfield Oil Corp. *(The Oil and Gas Journal, February 8, page 74).*

**R. W. Norton** has been appointed field superintendent of Newhall-Ventura, Santa Maria areas in the southern district of Standard Oil Co. of California, headquartered in Ventura, Calif. **G. C. Beckman,** who will maintain headquarters in Rio Vista, has suc-

# PERSONALS

ceeded Norton as field superintendent in the Bay area. **Kistler Wagy** has been named assistant to management at the firm's San Francisco office.

**J. Edward Brantly** and **C. Stribling Snodgrass** have opened geological and engineering consulting offices in Washington.

**Dr. Franklin Alton Wade** has been appointed head of the geology department of Texas Technological College at Lubbock, replacing **Dr. Raymond Sidwell,** who resigned to become a professor in the department. Wade, prior to the appointment, was a member of the geology staff at Miami University at Oxford, Ohio.

**William S. Farmer** has been transferred by Fullerton Oil Co. from Fillmore, Calif., where he was a chemist, to Hobbs, N. M., as an engineer.

**Gordon J. Buckle** has been promoted to district superintendent of British-American Oil Producing Co.'s southern district with offices in Houston. Buckle, formerly district engineer of B-A's central district in Oklahoma City, succeeds the late Errol J. Hesser as southern district superintendent.

**W. K. Neish** has been transferred from Lewistown, Mont., to head the new district production office of The Texas Co. at Williston, N. D.

**John O. Ely,** senior research technologist at Magnolia Petroleum Co.'s field research laboratories in Dallas, has been named the winner of the Socony-Vacuum Oil Co., Inc., incentive fellowship for 1954. Socony, Magnolia's parent firm, awards the fellowship annually to improve the academic training of laboratory employes who have shown more than usual ability. The company will pay Ely's full salary while he works toward a doctor of science degree in electrical engineering at Massachusetts Institute of Technology. Ely has been with Magnolia continuously since 1951.

## Rocky Mountain A.P.I. Names New Officers

**New officers of the Rocky Mountain district of the American Petroleum Institute's Division of Production are shown following their election at the district's spring meeting in Casper, Wyo. Left to right are H. C. Scoville, U. S. Geological Survey, Salt Lake City, vice chairman for Utah; Wayne E. Glenn, Continental Oil Co., Denver, vice chairman for Colorado; Fred J. Toth, Shell Oil Co., Billings, vice chairman for Montana; H. B. Gernert, Trigood Oil Co., Casper, district chairman; J. Howard Barnett, consultant, Casper, outgoing district chairman and chairman of the advisory committee; Homer B. Brown, Mud Control Laboratories, Inc., Casper, secretary-treasurer; and George Goodin, Petroleum Information, Casper, vice chairman at large. Not in the picture are R. M. Churchwell, Ohio Oil Co., Casper, vice chairman for Wyoming; Roy Fuller, Amerada Petroleum Corp., Williston, vice chairman for North Dakota; and J. S. Leonard, Ohio Oil Co., Sidney, vice chairman for Nebraska.**

**Edward H. Salrin** will retire on April 30 after 40 years of service with Tide Water Associated Oil Co. and its predecessor companies. He has for the past 20 years served as vice president and director of Tide Water Associated Oil Co. and chairman of the operating committee of the Mid-Continent division. In March 1929, Salrin became president of Tidal Oil Co. and held that position for 3½ years until Tidal was consolidated with Tide Water. He was in Tulsa from 1914 to 1929 when he was shifted to Tide Water's New York office, and then was transferred to Houston in 1932. Since then he has directed Tide Water operations in the Mid-Continent area from joint offices in Tulsa and Houston.

**Jay Dyer,** formerly with Cities Service Oil Co., has joined Anderson-Prichard Oil Corp. as area geologist in Oklahoma City.

**William Tutten,** geologist for Phillips Petroleum Co., has been transferred from Midland, Tex., to Bartlesville, Okla.

**G. D. Maddox** has joined Panuco Oil Leases, Inc., as division manager at Parkersburg, W. Va. From 1948 to 1951 he was assistant professor of petroleum engineering at the University of Oklahoma, Norman. Since then he has been production superintendent and consulting engineer for various independent companies in Oklahoma City.

**E. J. Hyde** has been promoted in the pipeline department of Standard Oil Co. of California to superintendent of the central district, headquartered at Kern River, Calif. He succeeds the late E. F. Hudson. **N. B. Sinclair** has replaced Hyde as superintendent of operations control at San Francisco.

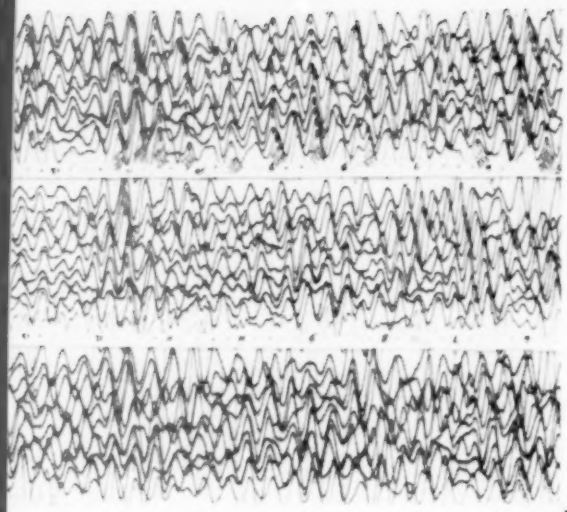
# DEATHS

**William H. Whittekin,** 71, former vice president and export manager of Oil Well Supply Co., was killed in an automobile accident near Dallas recently.

**W. A. Wattison,** 46, was killed recently in an automobile accident in South Louisiana. He was ad valorem tax manager for Tennessee Gas Transmission Co.

**Samuel K. Black,** 62, Independence, Kans., died recently in Kansas City. He had been with Sinclair Refining Co. about 25 years.

**William Marshall Fulton,** 84, died recently in Shelby, Mont. He entered the oil industry in Pennsylvania and later worked in Oklahoma, Texas, Kentucky, Idaho, and Montana. He was among the first operators in Pondera and Kevin-Sunburst fields of Montana. In 1936 Fulton was elected vice president for Montana of the Independent Petroleum Association of America.



Journal's Annual

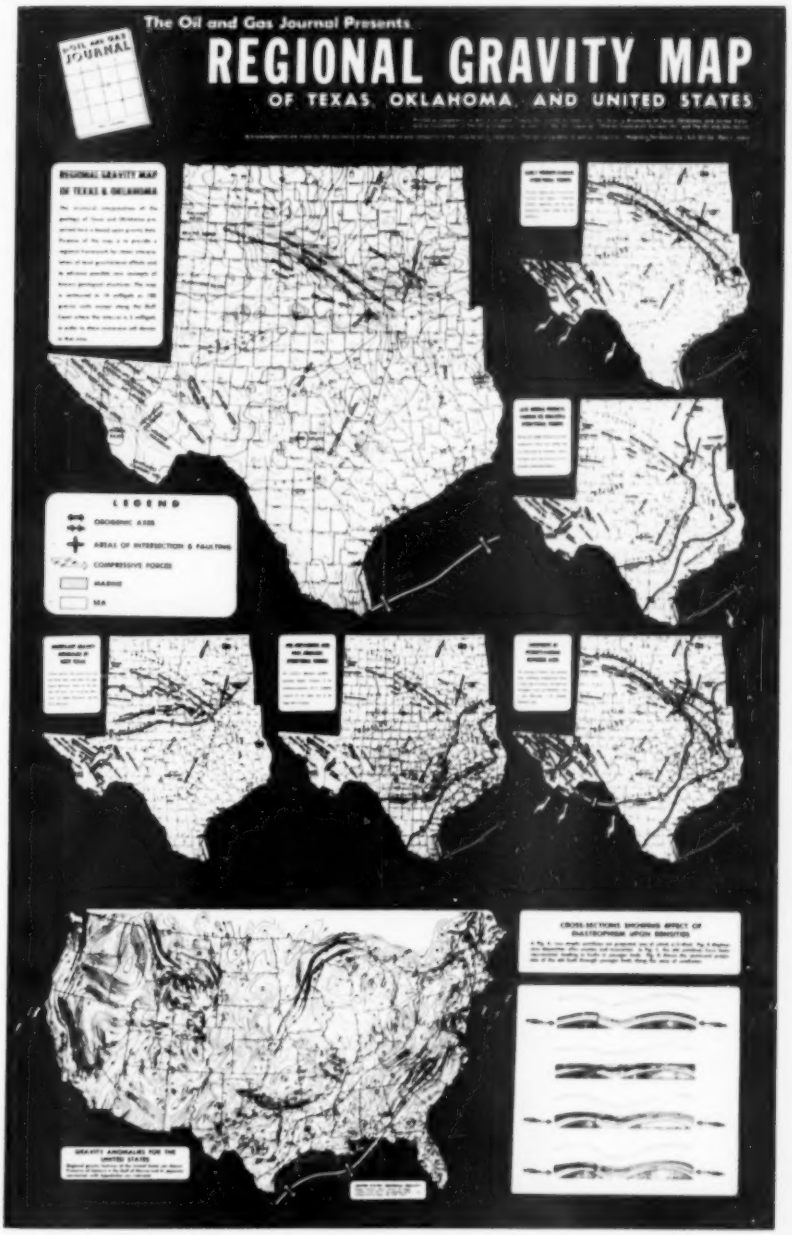
# Exploration

SECTION

## Featuring . . .

### Gravity Anomalies

of Texas, Oklahoma, and the United States, with 28 by 35-inch insert map




### Pattern Shooting

Current seismic techniques used in conjunction with multiple seismometers

### 1953 Exploratory Drilling

Lahee's annual report on the year's drilling successes

### 1953 Geophysical Activity

World summary of this important exploratory method

Plus digests of professional society papers, and articles of current geological interest

*First...* **THE IDEA!**

**For centuries man dreamed of flying. At last flying machines were made, and developed into today's supersonic planes. Man also dreamed of searching the earth's sub-strata with surface instruments, and the science of oil exploration developed, to bring you the accurate Mayes-Bevan Gravity Meter and Seismograph surveys of today.**

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Logs at right were run in a cased well in the Illinois Basin area. Note the greater detail on the Geo-Log, the sharp breaks indicating clearly actual thickness and quality of strata as well as depth.

**SIMPLE TO OPERATE** • • • •

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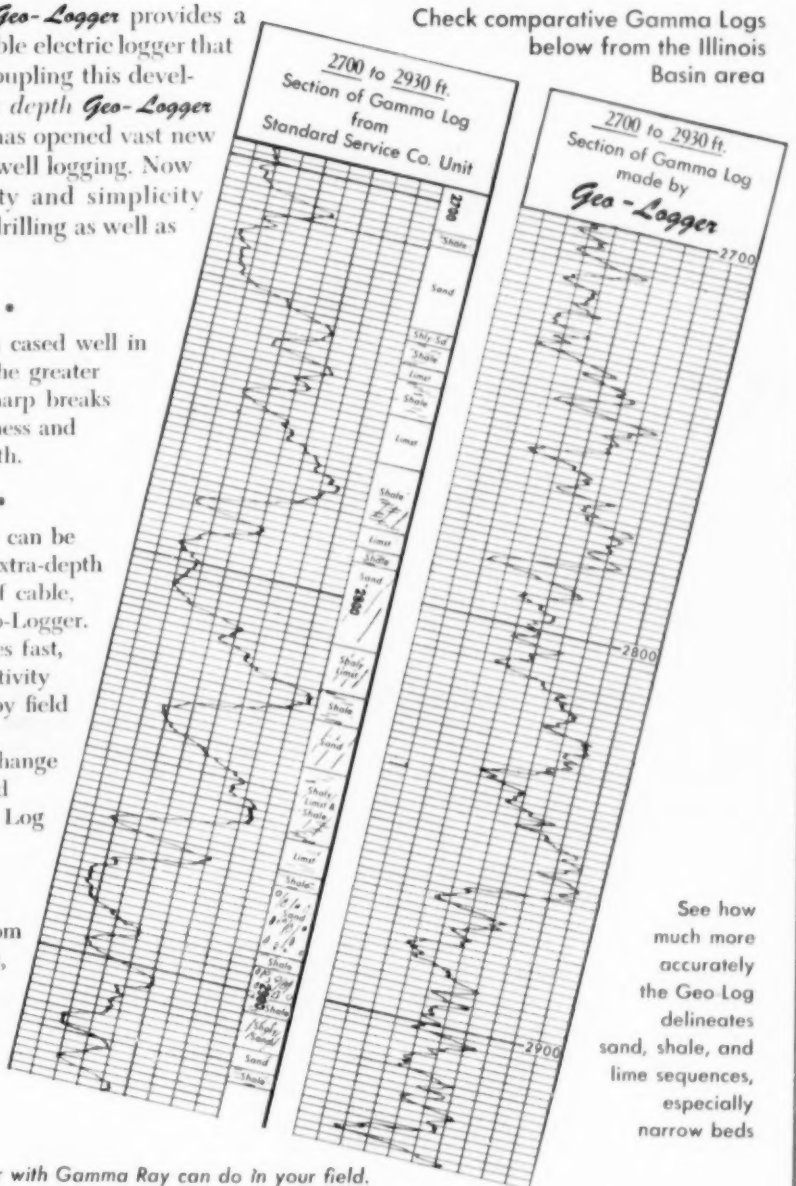
Check comparative Gamma Logs below from the Illinois Basin area

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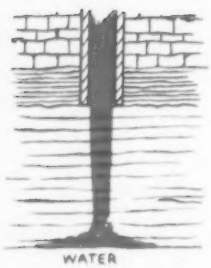


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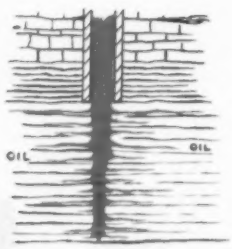


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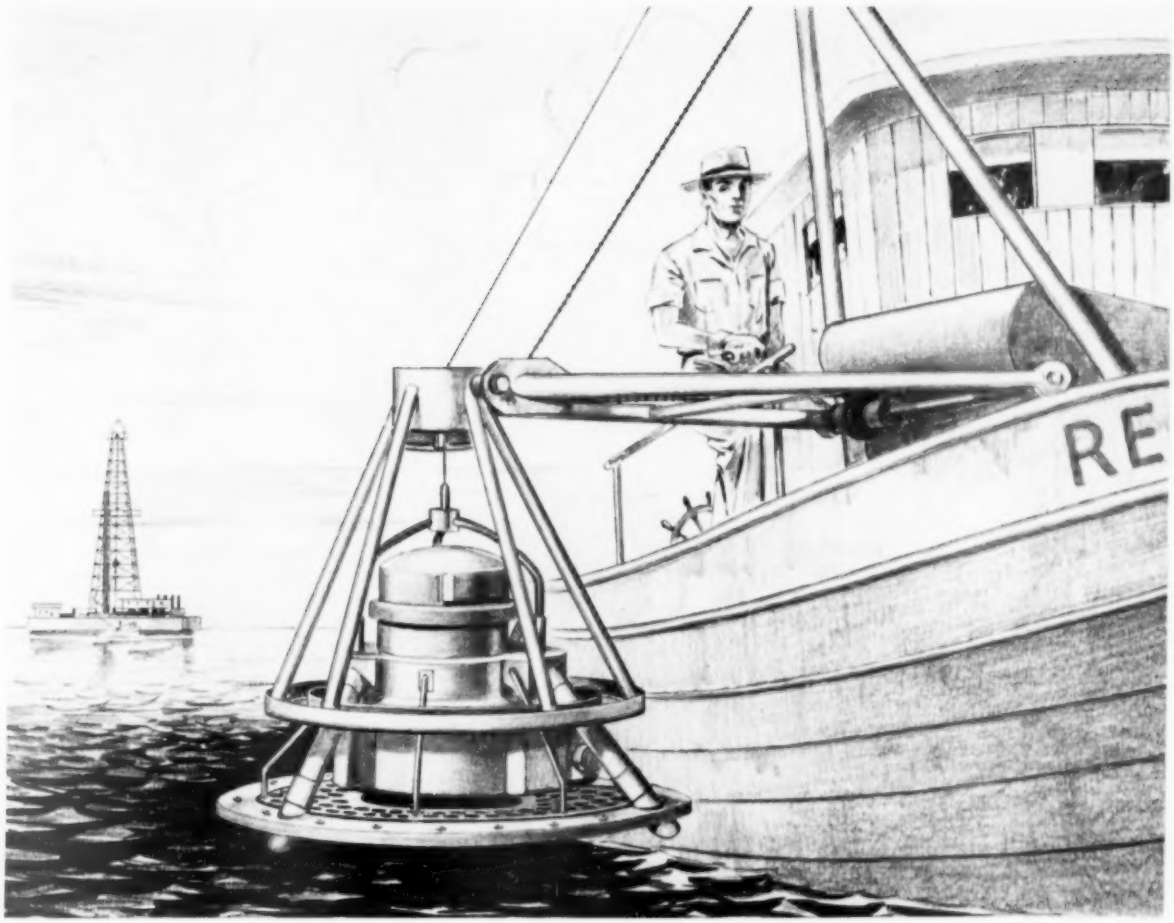

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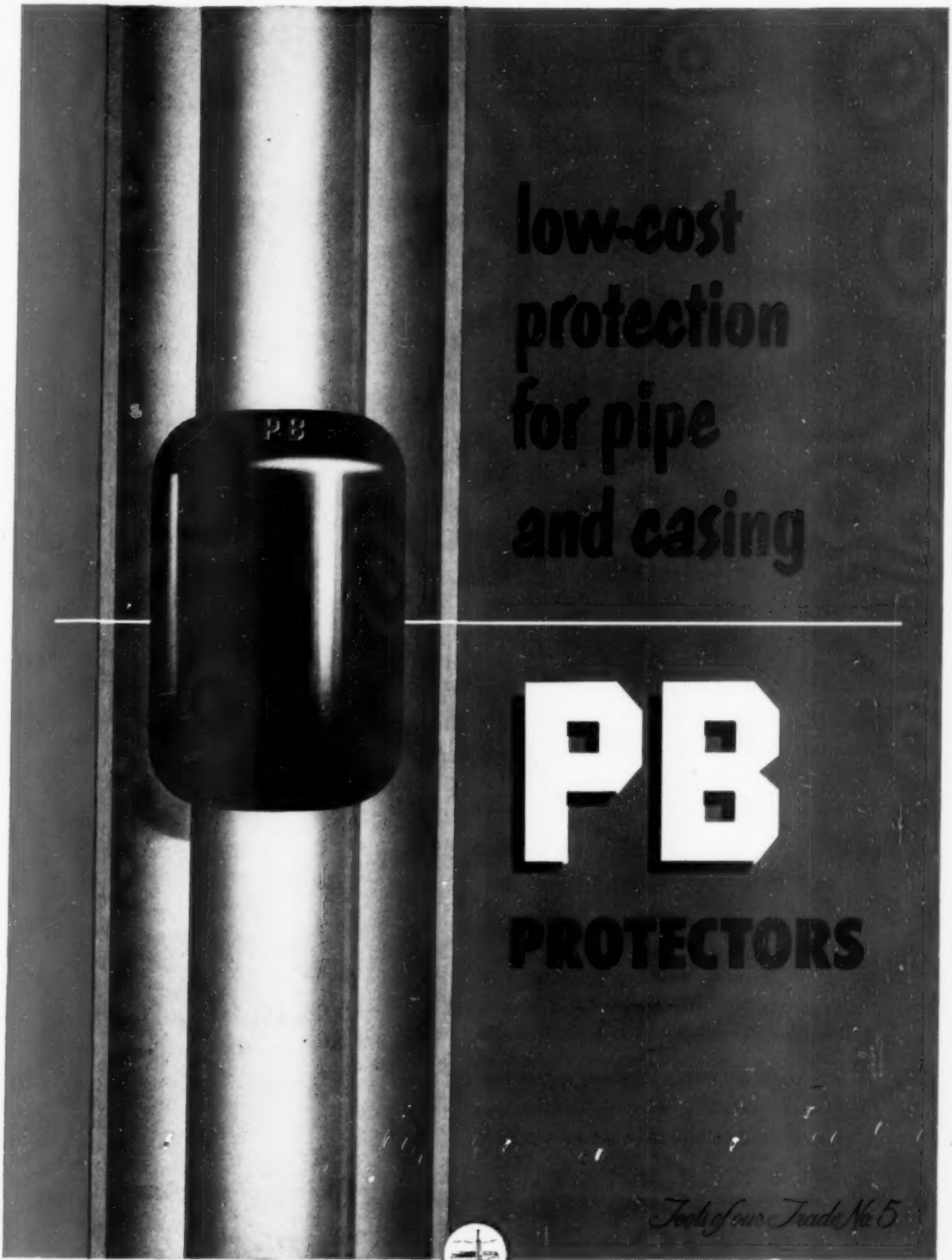


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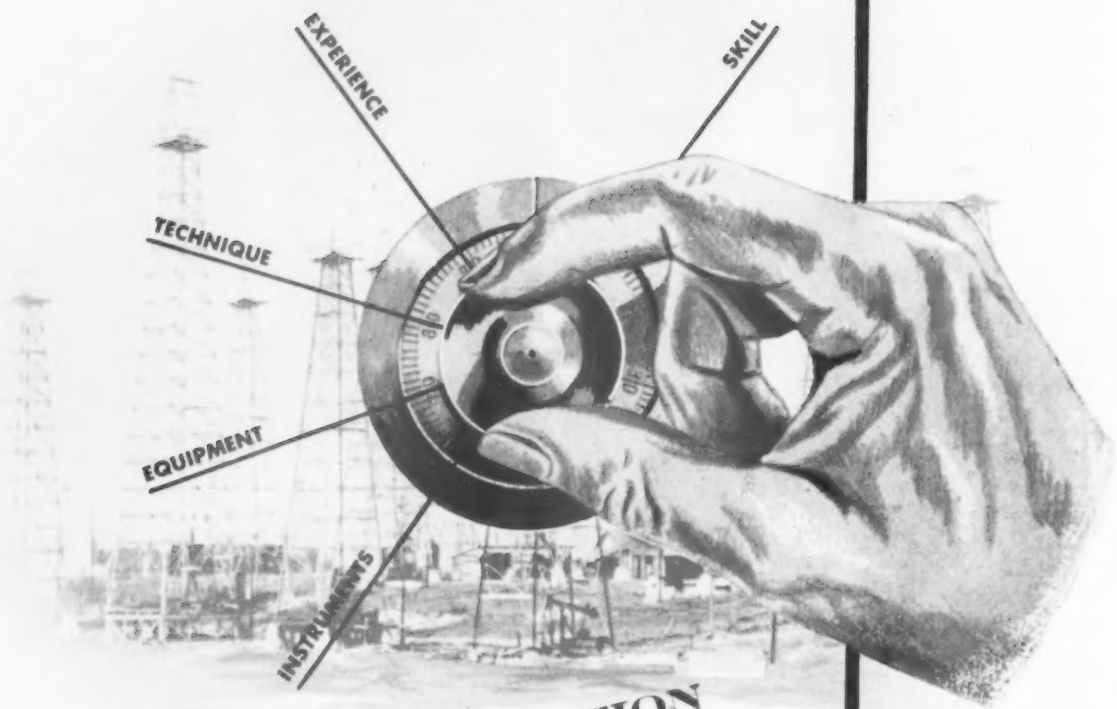


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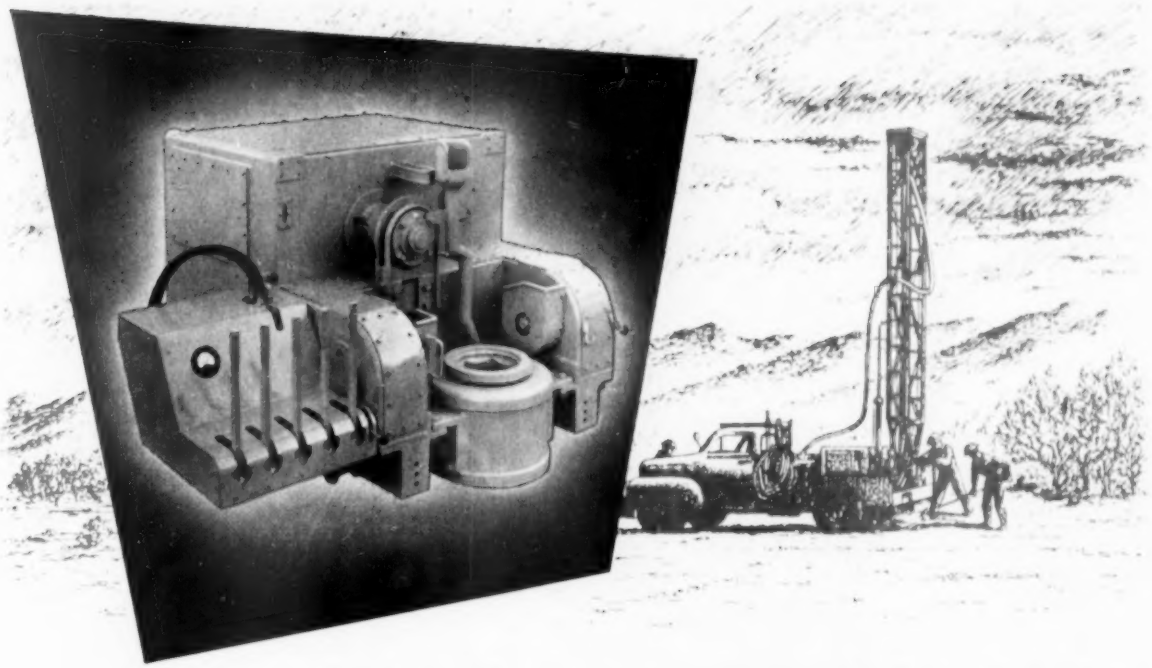

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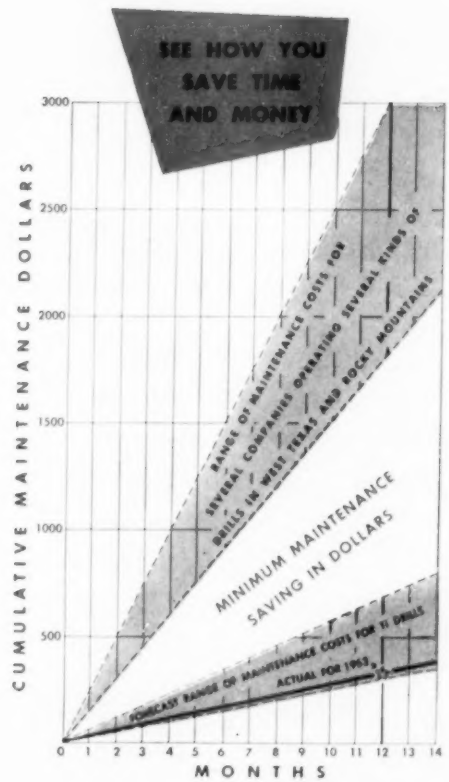
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MINIMUM MAINTENANCE SAVING IN DOLLARS
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ACTUAL FOR 1953

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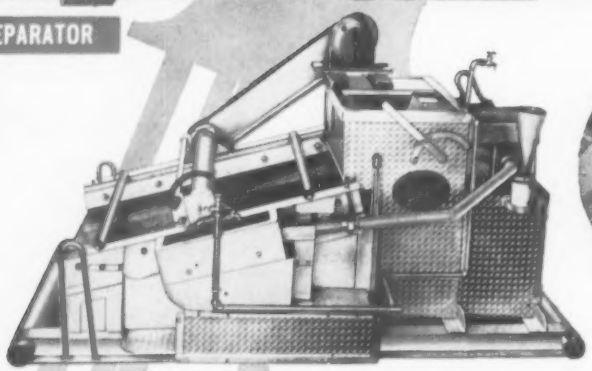

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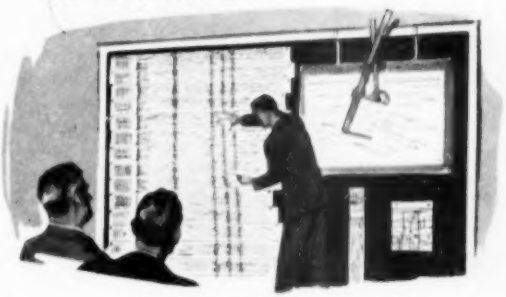

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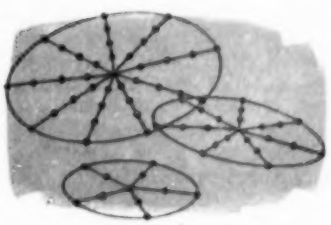

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# Gravity Anomalies...

## of Texas, Oklahoma, and the United States

**Special Insert Map With This Issue . . .**

Accompanying this April 19, 1954, Annual Exploration Number is a multicolor 28 by 35-in. insert chart showing the gravity anomalies of Texas, Oklahoma, and the United States. Its five tectonic maps show the relation between the gravity data and other major structural axes, especially in the Mid-Continent area. Seven maps, in all, comprise the chart, which is a part of this article, and all are here discussed in detail.

**by Lester L. Logue**

A STRUCTURAL interpretation of the geology of Texas and Oklahoma is presented, based upon gravity data. This map, entitled Regional Gravity Map of Texas and Oklahoma (see insert multicolor chart) was originally conceived and assembled to obtain an improved regional structural concept and to provide a suitable backdrop for more local gravitational correlations with geology.

The map is contoured to 10 milligals or 100 gravity units. This appeared to be the most convenient contour interval and the one that shows the structural trends most clearly without cluttering detail. On the Gulf Coast, 5 milligals were used since this interval made it possible to show numerous domes which otherwise would have been eliminated by a larger contour interval.

### Basic Concepts

To understand fully the concept and theory which will be projected here, certain basic principles of gravity should be borne in mind. **The primary principle is that diastrophism leaves density changes in sedimentary formations which continue to exist as long as the formations are in situ.** An excellent illustration of this can be found in the cross-sections showing effect of diastrophism upon densities. (See insert multicolor chart).

In Fig. A, two simple anticlines are projected, one of which is faulted. In Fig. B, the anticlines have been eroded and truncated and subsequently new formations have been deposited on top of the truncated surface. In Fig. C, new forces have reaccentuated the old anticlines, resulting in the faulting of the younger beds, and in Fig. D, the fault carried through the younger beds along the old zone of weakness. Should one try to interpret the gravitational results with the surface formations in the above illustrations, difficulties would be met from Fig. B on through Fig. C. It should be added here that unconformities provide the most serious obstacle in gravity interpretation.

Gravimetric results show the cumulative effects of igneous and sedimentary deposition as well as those of tectonics since time immemorial. The latter point is stressed with a great deal of emphasis since it provides the basic concept of this paper.

Diastrophism and tectonics leave density changes in formations which could be likened to geological fossil records. As long as the formations are not completely eroded away and redeposited, the history of tectonic movements will be recorded in the rocks by means of density variables.

**Old approach . . .** In the past, since geologists were chiefly concerned with highly localized areas, the tendency has been to consider tectonic trends in a restricted sense. This is not intended as a condemnation of geological practice. Unfortunately, a geologist involved in tracing one horizon is not in a position to see the tectonic history of the entire area from examining just one formation.

By the same token, the physicist concentrates more on the mathematical aspects of gravity.

An interpretational vacuum therefore exists between the geologist who is largely restricted to the province in which he is working, and the physicist who is principally involved in resolving gravity data to a mathematical solution. It is believed this vacuum can be filled with great advantage to both the geologist and the physicist.

Although many research geologists work primarily on a regional basis, most geologists are engaged in working in highly restricted areas. This is not emphasized as a geological shortcoming, but rather it is stressed as the cause of an abundance of local geological terms for the same orogenic axes. Perhaps this is best illustrated in West Texas. An examination of the Regional Gravity Map of Texas and Oklahoma (see insert multicolor chart) with its correlation with the local geology simplifies the structural aspects of that area, and demonstrates that numerous geological terms overlap. The same is true of the Muenster arch, which has been generally classified as a segment of the Red River uplift; in reality, its history is undoubtedly linked with the Wichita Mountains.

No attempt is intended to resolve any local tectonics and stratigraphic relationships, since this is a regional paper. It is hoped that this paper will motivate geologists who are more familiar with local areas to initiate local interpretations of geological axes of structure.

**Value of gravity data . . .** To induce geologists to use regional gravity in historical, structural, and stratigraphic work, it might be well to list here the most important advantages of regional gravity studies. These are:

1. Aids in deciphering the tectonic history of an area.
2. Separates major structural trends from minor and more highly localized structures.
3. Reveals sedimentary source areas.
4. Provides valuable stratigraphic information regarding types of beds

**"Gravimetric results show the cumulative effects of igneous and sedimentary deposition as well as those of tectonics since time immemorial. This point is stressed since it provides the basic concept of this paper."**

which can be anticipated (i.e., basins, reefs, and barriers).

As an illustration of Item 1, the indelible print which tectonics leave in the way of density contrast on formations has already been discussed.

In Item 2, regional gravity can simplify to a considerable extent the present nomenclature of West Texas. Another good illustration of the gravitational simplification of the literature is the Matador arch. Geologically, this feature deserves no recognition as a major feature. This is apparent from the gravity map.

Item 3, in which regional gravity throws new light on sedimentary source beds, will be explained at length when discussing Llanoria.

Item 4 will be demonstrated later in this report, along with the Ouachita facies.

If the above four advantages are borne in mind, regional gravity can be of infinite assistance to research geologists and stratigraphers in making regional correlations and regional structural studies. It might indeed change the complete structural geologic concept of some areas.

### Structural Analysis of Texas and Oklahoma

The problems which are presented here plus their solutions could indeed involve the writing of several books. Essentially, then, the data herewith presented are a suggested skeleton framework for future regional geologic research. Several changes will be made on previous **basic geologic concepts.** Such changes, of course, are theoretical at this time, but it is believed that they will be confirmed as wells are drilled and geophysical methods are improved. Since the concepts presented here are somewhat revolutionary, they are presented as the considered opinion of the author.

**Regional picture . . .** Gravity anomalies for the United States are shown on the insert map. A positive trend is present in the Appalachian Mountains, which does not coincide with the present axes of the mountains. This positive trend has been extended on a line with the axes indicated on the map of the United States. Utilizing land control, contours have been interpolated in the Gulf of Mexico. These contours show an obvious maximum of considerable areal extent off the south coast of Texas.

The presence of this maximum is confirmed by other geophysical means. This confirmation has come from discussions with individuals who are associated with water work off the coast of Texas. To date, the author has not obtained any prediction as to the depth of the feature shown, nor are the exact limits known. This buried structure may embrace considerably more area than has been indicated on the gravity map.

According to this interpretation, the tectonic axis of the above-mentioned maximum extends up through the Appalachian Mountains, or to be more specific, somewhat east of the Appalachian Mountains, as shown on the gravity map.

In conjunction with the maximum trend, which is indicated off the south coast of Texas, a minimum trend is apparent on the map. These minima demonstrate that the basins extending from the Gulf Coast through the Tyler basin on through the southern part of Arkansas continue into the Eastern Interior basin and thence into the Appalachian geosyncline. It does not take much imagination to see from the map that there obviously is a connection.

**Position of Llanoria . . .** In the case of the Appalachian geosyncline, the old axis which provided the source beds for the Appalachian geosyncline was called Appalachia. To the south, the axis that provided the chief source of sediments for Texas has been referred to as Llanoria. It is highly probable that Llanoria is indeed the large maximum existing just south of the Gulf Coast and that Llanoria is a structural extension of Appalachia. This is a change from previous theories regarding the position of Llanoria.

The author is not able to state at this time which maximum coincides exactly with ancient Appalachia. This problem could probably be resolved after a thorough geological study of the area. A correlation along one structural axis which carries down into the Gulf of Mexico is shown. Geological examination might shift the axis to the series of maxima which lie to the east.

A study of the gravimetric data and the geological history of Texas and Oklahoma was made in order to determine the age of specific structures. The various important orogenic axes which have existed since early Pennsylvanian time are shown on the insert chart. No effort was made to incorporate the orogenic axes which existed prior to early Pennsylvanian or since late Cretaceous time. The author considers that the major movements from a structurel standpoint occurred from the Pennsylvanian through the close of Cretaceous time. In addition, space does permit a discussion of all orogenic movements.

**Early Pennsylvanian orogeny . . .** A positive tectonic axis existed, here called Appalachia to the north and Llanoria to the south, together with a very obvious geosyncline to the north of the axis trend. The map entitled Early Pennsylvanian Trends gives a closer look at Texas and Oklahoma and is the author's concept of the early Pennsylvanian orogenic axes. The exact time of the tectonics has been purposely omitted because the orogeny probably occurred over a considerable period. In other words, orogenic movements were taking place even during the time of deposition.

Accordingly, the map is called the early Pennsylvanian orogenic axes because no attempt was made to time the disastrophism exactly. It is probable that the axes became active in early Bend or Morrow time in Texas and continued until Des Moines time, which would be pre-Strawn in Texas and late Atoka time in Oklahoma.

The direction from which the tectonic forces originated to create the structures is shown. This is significant since the tectonic compressive forces which created these structures acted at right angles to the ancient axes of Llanoria.

Llanoria is indicated as quiescent during early Pennsylvanian time. Deposition at this time was relatively slow and sediments are well sorted. In ad-

### THE AUTHOR

**L. L. Logue, vice president-secretary of Exploration Surveys, Inc., Dallas, took undergraduate work at Pennsylvania State College and graduated from Indiana University with an A.B. degree in geology in 1937. After a year of graduate work in geology, he was employed by Creole Petroleum Corp. in Venezuela from 1937 to 1941. During the war he was in the Corps of Engineers, spending 3½ years in Africa and Italy. In 1946 he joined Exploration Surveys, Inc., as secretary-treasurer upon its incorporation in Dallas and later was promoted to his present position. For the past 8 years he has been actively engaged in gravitational interpretation and geological research.**

dition, the sediments are of definite marine origin, indicating that the axes were created during deposition.

**Ouachita orogenic phase . . .** The orogenic axes of late-Middle Pennsylvanian or Ouachita time are shown on the map, Late Middle Pennsylvanian or Ouachita Structural Trends.

In early-Middle Pennsylvanian time, Llanoria was rejuvenated to a considerable extent. The area indicated as a basin lying just to the north of Llanoria was inundated with a tremendous quantity of materials resulting in what is known now as the Ouachita facies. The updip barrier of the facies is indicated on the map. This barrier has been generally accepted geologically; however, it has never been pointed out that the barrier coincided with the series of gravitational maxima trending in the same general area.

The barrier or the maxima which can be noted along this trend also coincides with the Luling-Mexia-Talco fault system. Further north it generally coincides with the Choctaw fault system. Just north of the Arbuckles, the Ouachita facies turn abruptly to the east into the McAlester basin and continue into Arkansas. This barrier has been extended to the north through Oklahoma and into Osage Island. The reason for extending the barrier in this way was due to a very obvious tectonic trend developed in that direction.

It is the author's contention that Llanoria was the primary source of the Ouachita facies sediments and that this land mass is shown in the Gulf of Mexico. It is further the author's contention that the barrier indicated on the map separated the brackish facies of the Ouachita from the marine facies present to the west of the barrier.

It might be wise at this point to provide a supposition for the coincidence of the Luling-Mexia-Talco fault trend along the axis of the barrier and its conformance with the actual updip limits of the Ouachita facies. The obvious answer appears to be that during Ouachita time the basin was subsiding at a considerable rate of speed because of the volume of sediments which were being deposited, resulting in rim fractures around the edges of the basin.

One axis trend apparently was not existent in early Pennsylvanian time. This axis has been called the Toyahvale maximum, which separates the Delaware basin to the north from the Pecos minimum to the south.

**Relationship between Ouachita and Early Pennsylvanian orogenies . . .** The conflict of the tectonic axes in early and late Pennsylvanian times is demonstrated on the map, Composite of Pennsylvanian Orogenic Trends. It is readily apparent that compressional forces came from the southwest in early Pennsylvanian time and from the southeast from Llanoria in Ouachita time.

Considerable fracture and distortion occurred where those axes intersect.

A good illustration exists in West Texas at the junction of the Toyahvale maximum and the Alpine maximum, an early Pennsylvanian trend. The intersection of tectonic axes in this area has probably resulted in the lava flows in Jeff Davis County, the Marathon uplift, and numerous other structures.

A second intersection of tectonic axes is in the vicinity of the Arbuckle Mountains. At this junction, of course, most geologists are aware of the tremendous faults present in the area. The Arbuckle Mountains may be a huge horst rather than an elongated tectonic trend. Areas of extreme faulting occur at the junction of the main tectonic axes and are indicated by the "crosses" at the areas of diastrophism. (Composite of Pennsylvanian Orogenic Axes, insert chart).

In Ouachita or late middle Pennsylvanian time, the Ouachita sea occupied a major portion of what is now known as the Tyler basin and the Gulf Coastal basin. Hence rocks of Ouachita facies should underlie the present Cretaceous and Cenozoic beds in this general area.

During late middle Pennsylvanian or Ouachita time, the erosion of Llanoria continued at an extremely rapid pace until Llanoria was stabilized and became quiescent. In late Pennsylvanian time, the seas shifted again and the area along the Gulf Coast and the Tyler basin was undoubtedly exposed to erosion; deeper marine deposition continued in West Texas and practically all of Oklahoma.

After the Appalachian Revolution and the raising of the major portion of Texas and Oklahoma above sea level, subsequent movements were relatively simple and readily determinable. The primary interest, however, is to project a structural framework for the areas, based on the major tectonic movements.

**Pre-Cretaceous structural features . . .** In pre-Cretaceous or post-Jurassic time a very definite barrier again was erected between West and Northwest Texas and Oklahoma from the Gulf Coast and the Tyler basin. This is emphasized by the presence of the Eagle Mills salt which has been variously placed as being pre-Comanchean, post-Jurassic, Lower Cretaceous, or Upper Jurassic. During this period of time, the Tyler basin and the Western Gulf embayment were landlocked and received considerable amounts of salt water from the adjacent seas. Apparently a barrier existed southwest of the present Tyler and Gulf Coast basins. This barrier permitted the entry of salt water into the basin where it evaporated and the Eagle Mills salt was deposited.

In order to have such a basin, it is necessary to have a barrier to the northwest, to the northeast, and also to the southeast. It is felt that the presence of the Eagle Mills salt in the Tyler basin and along the Gulf Coast is perhaps the most conclusive evidence that Llanoria existed in the places where it is indicated to be.

Again, it should be pointed out that the barrier is the maxima along the Luling-Mexia-Talco fault trend. North and northwest of this point no salt exists. To the south and southeast the salt domes are prevalent. To have a basin which is landlocked, one must find conditions that are very similar to those which exist in the Dead Sea today.

Such conditions existed during early Cretaceous or late Jurassic time and there must have been barriers on all sides. In this particular case, of course, the southeast barrier coincides with what is termed Llanoria.

The preceding historical analysis of Texas and Oklahoma has covered the high points in the tectonic history of the Mid-Continent area and has pointed out the gravitational delineation of the important features.

**"Regional gravity can be of infinite assistance to research geologists and stratigraphers in making regional correlations and regional structural studies. It might indeed change the complete structural geologic concept of some areas."**

### Significant Gravity Anomalies of West Texas

**Abilene basin or minimum . . .** There are, however, certain maxima and minima which to date have not been actively associated with geological definition as we know it. (See Significant Gravity Anomalies of West Texas—insert map).

Perhaps the best illustration is the Abilene minimum in Martin, Howard, Mitchell, Fisher and Jones counties,

Texas. The author considers that the Abilene minimum represents a fossil basin of probable pre-Cambrian age. Its exact delineation might be better understood when more definite information about the pre-Ellenburger formations is known. There are several reasons for believing that such a basin exists.

The first reason is the fact that the Plainview basin, which may be older than the Midland basin, is located just to the north of the area where the barrier is indicated.

The maxima along the barrier are believed to be a series of pre-Cambrian structures which have been since truncated and inundated. One, the Crosbyton dome, which is located in the southwest part of Crosby County, has been delineated by geological means. The others will be confirmed when more geological information becomes available on deeper beds.

The presence of such a barrier is well demonstrated by the difference in the stratigraphy of the sedimentary beds in the Plainview basin and in the Abilene minimum or basin.

Another left-handed means of assuming that a tectonic trend was present in this area, probably during pre-Cambrian time and possibly as late as early Pennsylvanian time, is the present axis of some of the reef developments in Scurry and Kent counties, which generally coincides with the maxima as delineated. It is the author's belief that there is a very active association, the extent of which will probably be demonstrated as time goes on.

**Toyahvale maximum . . .** A significant maximum which requires clarification is termed the Toyahvale maximum in the northern part of Pecos County. This maximum separates a strong minimum in the south part of Pecos County from the Delaware basin. A second basin probably exists south of the Toyahvale maximum. This basin may be similar stratigraphically to the Delaware basin, but will indeed be an entirely different basin.

**Alpine maximum or uplift . . .** The term Alpine maximum has been applied to the anomaly lying in the south part of Jeff Davis County and extending into Brewster County. It was necessary to include this term because lava flows obscure the subsurface geology. This is a convincing demonstration of the power of gravity to delineate structural trend beneath lava flows.

It was felt that the general axis needed to be tied together and the term Alpine maximum was applied to the maximum separating the Guadalupe-Delaware - Apache Mountain range from the Santiago-Carmen Mountains.

Space does not permit going into detail regarding the various deviations of gravity from the present geological concept. The author is convinced that such deviations will be resolved as additional geological information becomes available through deeper drilling.

The Abilene minimum, which is believed to be a pre-Cambrian fossil basin, the Toyahvale maximum, and the Alpine maximum have been described as gravimetric features in order to point up their existence. Subsequent geological delineation may demonstrate the presence of the basins and accordingly specific names should be applied. Alpine maximum could conceivably be called Alpine uplift when geological evidence confirms its presence. The same procedure could be applied to the other features.

With reference to the Abilene minimum, a considerable thickness of the Pack-saddle schist of pre-Cambrian age is exposed to the south in the Llano uplift. The schist consists primarily of metamorphosed sandstones, limestones and shales. The natural assumption is that in the Abilene minimum, the thickness of the schist will be considerably more than in areas where it has been uplifted and truncated.

**"Gravity can be used to maximum advantage in establishing tectonic axes and giving a broad concept of orogenic axes. Gravity can take out of the dark of speculation certain inferences which have been made in the past relative to geologic history and give actual physical substance to orogenic history."**

### Conclusion

From the foregoing, certain definite conclusions can be drawn:

1. Gravity can be used as a means of establishing the tectonic stratigraphic and historical framework of regional geology.

2. Gravity can be used to maximum advantage in establishing tectonic axes and giving a broad concept of orogenic movements.

3. Regional gravity can give a tectonic framework to geologists in their studies of stratigraphy and sedimentation.

4. Gravity can take out of the dark of speculation certain inferences which have been made in the past relative to geologic history and give actual physical substance to orogenic history. A good example of this might be the Llanoria-Appalachia concept.

In addition to the above, regional gravity can indicate basins which heretofore were not believed to have existed or were believed to have been a part of other basins. It can indicate areas where approximate barriers may have existed, thus creating conditions favorable for the creation of reefing. It can tie the local structural concepts to the regional.

From the above it can be readily inferred that regional gravity can become, indeed, a valuable geological tool for the stratigrapher.

Accordingly, it is hoped that this first attempt at an analysis of the regional gravity of Texas and Oklahoma will lead to further evaluation of regional gravity by other geologists and physicists. Perhaps this will result in a simplification of the historical and stratigraphic geology of Texas and Oklahoma and a clarification of geologic nomenclature.


### Acknowledgment

Several years back, Exploration Surveys, Inc., compiled the first accurate regional gravity map of Texas and Oklahoma. The original purpose of compilation was to provide a regional framework to interpret more closely local gravitational effect.

In 1953, because there appeared to be such a demand for the map, it was revised and reissued as a courtesy to the oil industry.

The regional gravimetric map of United States is modified from the map published by Paul L. Lyons, in the Tulsa Geological Digest, 1950.

The author is particularly indebted to Sun Oil Co., and Harry Rose; to Magnolia Petroleum Co.; Paul L. Lyons, consultant, and Don W. Jopling, president of Exploration Surveys, Inc. Were it not for this assistance, the map would not have the degree of accuracy which has been achieved.

There are a few areas, particularly in the southwest part of Texas, which could be more accurate. In addition to that, there appeared to be a decided lack of gravitational control in the extreme northeast corner of Oklahoma. Every effort was made to make the map as accurate as possible. Despite this, minor deviations undoubtedly will be found.

SYMPOSIUM . . . Current Seismic Techniques Used in

# PATTERN SHOOTING

## . . . utilized in conjunction with multiple seismometers

**AUSPICES . . .**

Geophysical Society of Tulsa

**PARTICIPANTS . . .** **J. A. Smith, geophysicist, Humble Oil & Refining Co., Houston; F. F. Reynolds, president, Seismic Explorations Inc., Houston; Ben F. Rummerfield, vice president, Century Geophysical Corp., Tulsa, moderator; J. W. Hammond, senior research engineer, Seismograph Service Corp., Tulsa; and A. E. McKay, president, Continental Geophysical Co., Fort Worth.**

# Why This Symposium?

**by B. F. Rummerfield**
Moderator

FINDING additional and adequate oil reserves is the direct responsibility of the exploration division of the petroleum industry and, more specifically, of the geophysical section of that industry. This fact is illustrated by superimposing a reflection quality map of the United States upon a map of the oil-producing areas. A tendency of the productive areas to cling to good record areas can be clearly discerned; this correlation becomes even more apparent if only the oil fields from 1935 to the present date are considered.

Areas of poor to questionable seismic results comprise a tremendous problem. These areas are concentrated in provinces where difficult surface or near-surface conditions prevail, such as the West Texas area; the Anadarko basin; Florida; portions of Mississippi, Alabama, Michigan, and Canada, and many others.

History of the solution of these areas, to date, has followed a general pattern of:

1. Ignoring difficult areas.
2. The use of deep holes.
3. Refractions and second arrivals.
4. Offset, arc shooting, and surface shooting.
5. Pattern holes and multiple geophones.

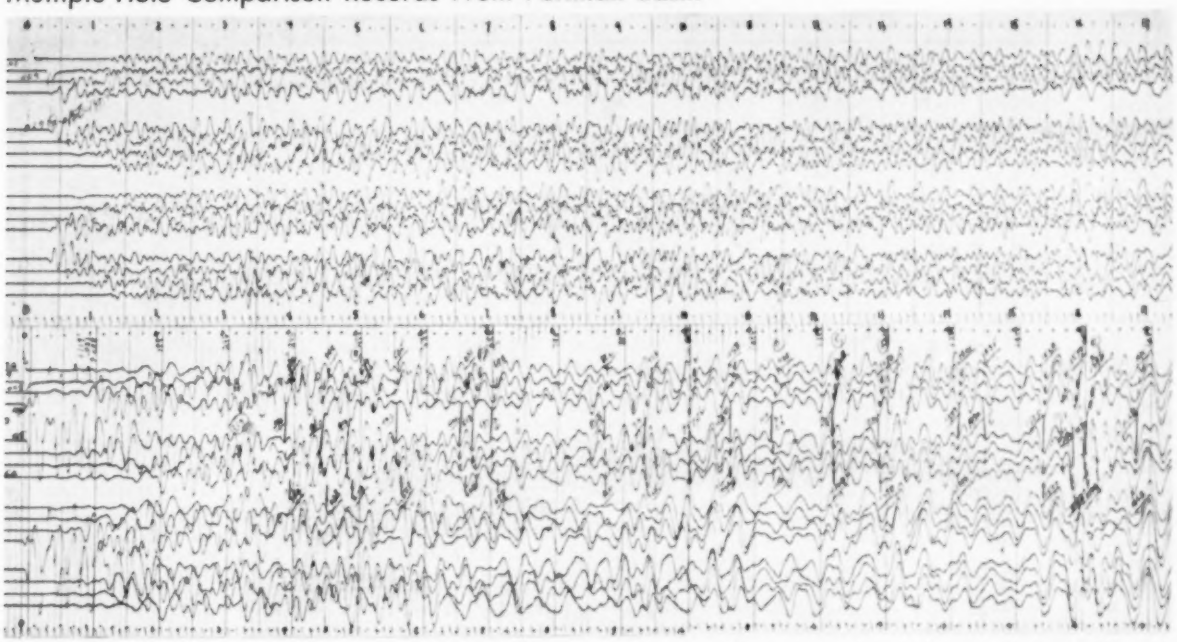
The next probable development is broad-band recording with a playback arrangement. However, it is believed that pattern holes and multiple geophone techniques have seriously affected the need of a playback arrangement for many regions.

In seismic exploration, it is generally agreed that the field and interpretive techniques have seriously lagged behind instrumentation developments. The purpose of the symposium is to discuss recent trends in the use of pattern shot holes and multiple geophones.

There appear to be two schools of thought as to why the pattern holes and multiple - geophone techniques provide satisfactory seismic data in areas heretofore considered seismically marginal. Those of the statistical school suggest that the use of a large number of shot holes and geophones provides a better coupling effect both for the transmission of energy to the reflecting horizons, and for the reception of the reflective signal from the same horizons. Also, they believe that the increased efficiency is due to unique distances from the source of seismic energy to each receptor, thereby canceling much of the random noise usually encountered in surface and near-surface beds. Noise effects being out of phase, cancels; the signal, being in phase, reinforces, and increases signal-to-noise ratio.

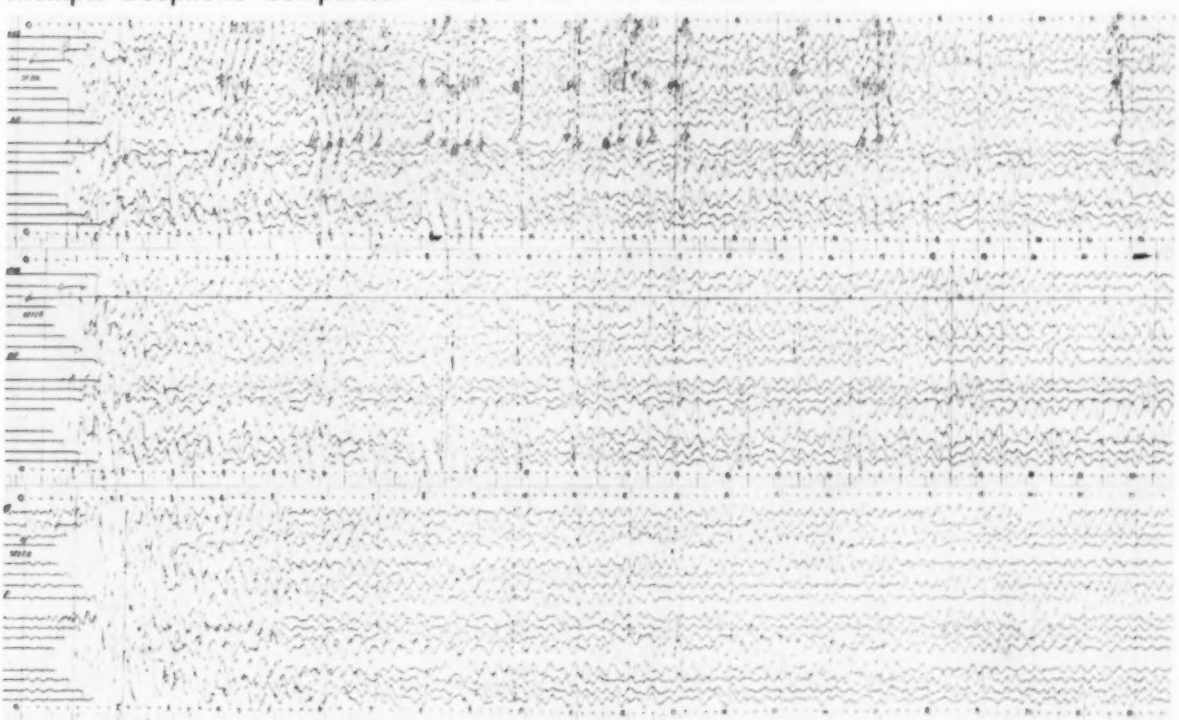
Followers of the selectivity school hypothesize that the distance between stations, and the symmetry of the patterns of both the shot holes and geophones, have a very pronounced effect upon the ability to record satisfactory seismic results. Spacings used and proposed by each group are directly de-

## Multiple-Hole Comparison Records From Permian Basin



**Top record is obtained from a 50-lb. charge shot in limestone at a depth of 158-180 ft., using 48 geophones per trace. Bottom record is obtained using the identical geophone spread with 5 lb. of dynamite shot in each of 36 shot holes at depths of 20 ft. Forty-eight geophones per trace were used on each setup. Dual recording with a straight and mixed record and different filter selections were used. The comparison illustrates the very marked increase of record quality obtained by the pattern shot points.**

## Multiple-Geophone Comparison Record From the Delaware Basin



**The three records show the increase of quality and additional deep information that can be derived by use of multiple geophones. All records were obtained from single deep holes shot at essentially the same depth. The lower record has 1 geophone per trace, the middle record has 12 geophones per trace, and the upper record has 36 geophones per trace.**

rived from the formula that velocity is equal to frequency times wave length. In effect, the field technique can be "tuned in" to most nearly match the frequency of the seismic reflected energy, and thus obtain good results.

### Summation

There is general agreement among the members of the panel that the use

of pattern holes and multiple geophones allows an improved means of mapping many areas in which previously it has been impossible to obtain usable seismic results. It was further agreed that there is no common denominator discernible whereby marginal areas can be solved by pattern shooting. Each area presents an individual problem. However, a few generalizations can be deduced, as follows:

1. The record quality generally improved with the number of geophones used.

2. Multiple holes and geophones are used to establish a better coupling between the energy and the transmitting media and to overcome noise set up by surface or near-surface beds.

3. Shallow-pattern shot points normally give best results in areas of high-speed surface beds, and deep-pattern shot points are most beneficial in areas of low-speed surface beds—but not always.

4. Spacing of shot points and geophones does have an effect upon energy reception. Spacings in terms of divisions or multiples of wave lengths have given best results to date. (Velocity = frequency × wave length.)

5. In many marginal areas, a thin mantle of sand over caliche or limestone may result in satisfactory seismic data. It seems to be difficult, if not impossible, to physically duplicate this condition—the length of time of the contact of the sand and high-speed bed may have a bearing on the intimacy of the coupling.

6. Use of multiple geophones establishes: (a) a unique distance from the energy source to each receptor and thereby cancels random noise and allows the signal, being received in phase, to reinforce. A marked increase of signal-to-noise ratio is noticed; (b) a much firmer coupling between the ground and receptors. The geophone plant is one of the most important variable factors over which we have control in obtaining good seismic records.

Where surface deposits of caliche exist, it is possible there may be local areas a foot or so in diameter in which good seismic energy cannot be recorded, regardless of the coupling. This condition could result from void spaces in the high-speed beds caused by the leaching action of ground water.

Some of the additional problems which were not discussed because of the lack of time are general interpretive problems. The need arises to think in terms of depth planes in which each trace on the seismic records represents return of energy from a group of independent depth points. Effect of such an arrangement upon faulted, complex, or steep-dip areas must be considered. Calculation of proper weathering and elevation corrections is another problem inherent in such shooting.

Additional costs of seismic exploration by these techniques must be considered. Average increase of approximately 25 per cent in total cost over standard shooting procedures is generally acceptable, particularly as the pattern work is normally utilized in regions where leasing and drilling costs are extremely high. Improvement in the quality as well as the depth of mapping control thoroughly justifies the increase in seismic costs in such areas.

It is generally recognized that the discussed field techniques are being satisfactorily used at present and that this form of shooting has considerably broadened the areas which can be adequately mapped by seismic methods.

Another step has been taken to provide the oil exploration industry with an additional tool to be intelligently used in the search for petroleum deposits.

## Here are some examples of

# Record Improvement in Bad-Reflection Areas

**by A. E. McKay**

IMPROVEMENT of seismic reflections in bad reflection areas is discussed for two regions: (1) western Oklahoma, and (2) the West Texas-New Mexico province. The poor record quality in both of these areas is well known and is generally attributed to near-surface high frequency interference.

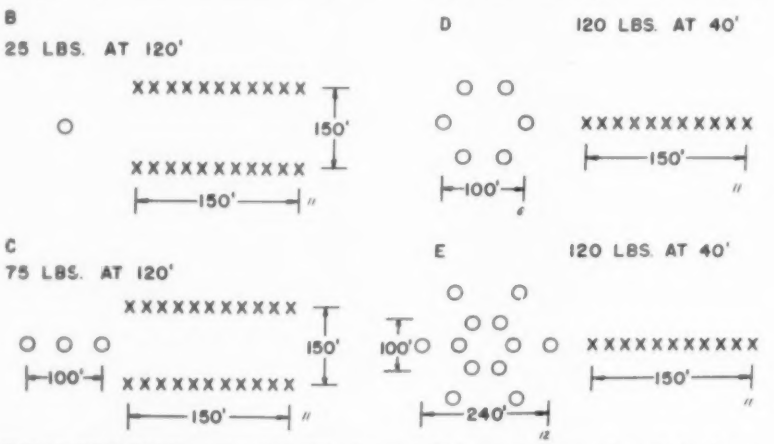
Here we will demonstrate with record examples the reflection character and quality that can be influenced by various shot-hole and seismometer arrangements. (Design of pattern arrangements is explained by other panel members.)

The first examples cited are in western Oklahoma, in Ellis and Harper counties, where the surface and near surface is the Quartermaster formation and the Cloud Chief gypsum of the Permian system.

Fig. 1 shows various spread diagrams, with circles indicating shot holes and x's indicating seismometers.

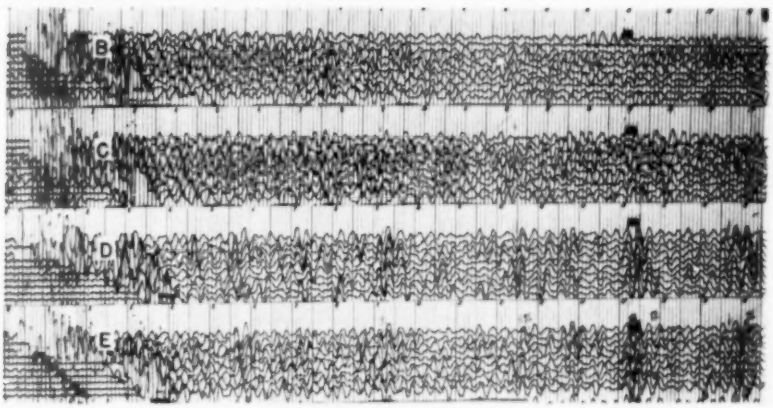
Fig. 2 shows the records obtained using the patterns illustrated in Fig. 1. All records are from, as near as possible, the same surface spread and shotpoint location.

Fig. 3 shows enlargements of the rec-




SPREAD DIAGRAMS employed in Ellis County, Oklahoma, in the northern limb of Anadarko basin. Circles indicate shot holes and X marks are positions of seismometers. Fig. 1.

This is part of a paper originally presented at Society of Exploration Geophysicists regional meeting, November 1953, Dallas.



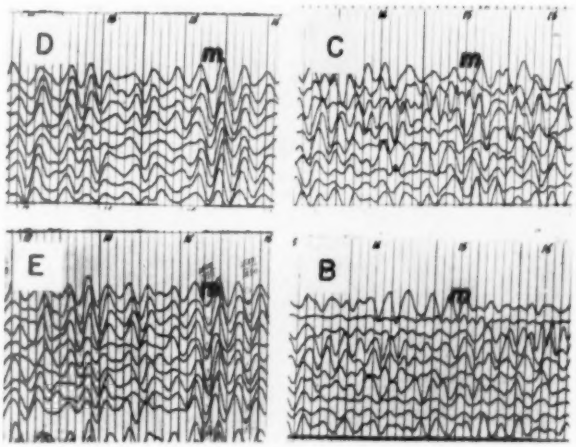

SEISMOGRAMS obtained using patterns shown in Fig. 1. All records were made as near as possible from the same surface spread and shot-hole location. Fig. 2.

ords in Fig. 1 at approximately Mississippian depth marked at 1.5 seconds.

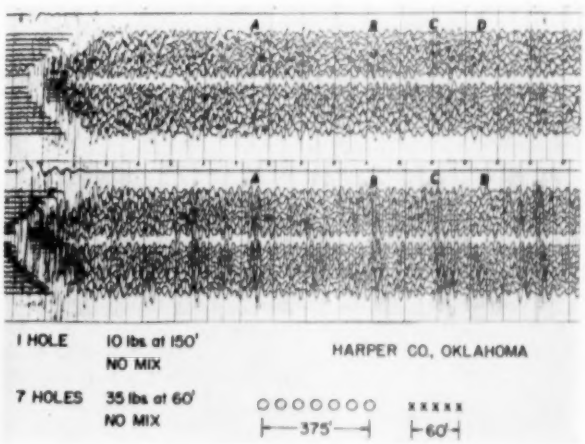
Spread B, Fig. 1, shows a single hole with 25 lb. shot at 120 ft. Seismometer arrangement is two parallel cables with the seismometers in line and with a total of 22 seismometers per trace. The record obtained with this arrangement is marked B in both Fig. 2 and Fig. 3.

Spread C indicates three shot holes in line 50 ft. apart, with a total of 75 lb. shot at 120 ft. Seismometer arrangement is the same as in Spread B, and it can be noted on Fig. 3 that some record improvement is beginning to show at Mississippian depth.

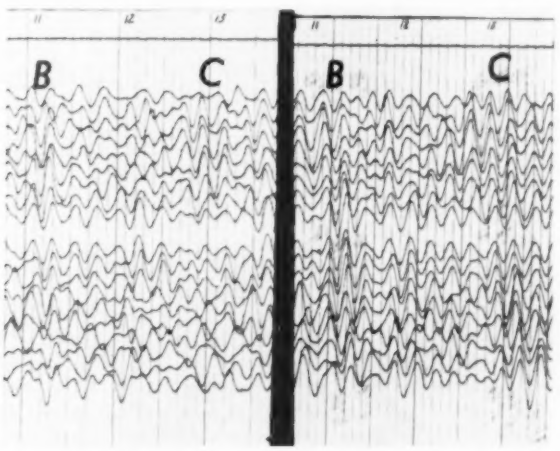
Spread D is an arrangement of six shot holes, with 20 lb. detonated simultaneously in each hole at 40 ft. The spread arrangement is 11 seismometers per trace in line over a total distance of 150 ft. Considerable reflection im-



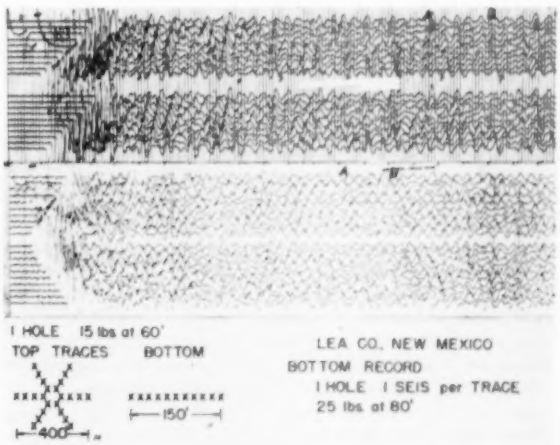

ENLARGEMENTS OF RECORDS shown in Fig. 2. Initial "m" marks arrival times of approximate Mississippian formations at 1.5 seconds. Fig. 3.



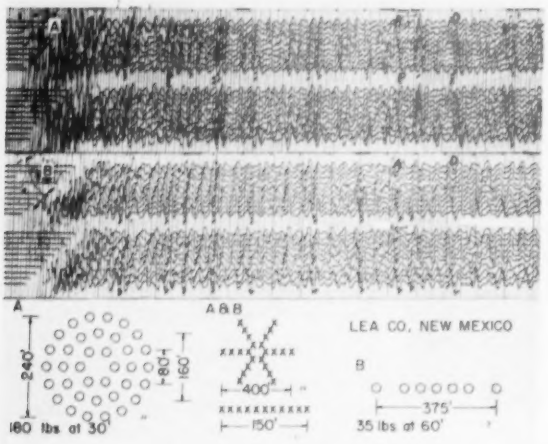

MULTIPLE SHOT HOLES were employed in shooting to obtain lower record which shows considerable improvement of all reflections over upper record made from single hole. Fig. 4.



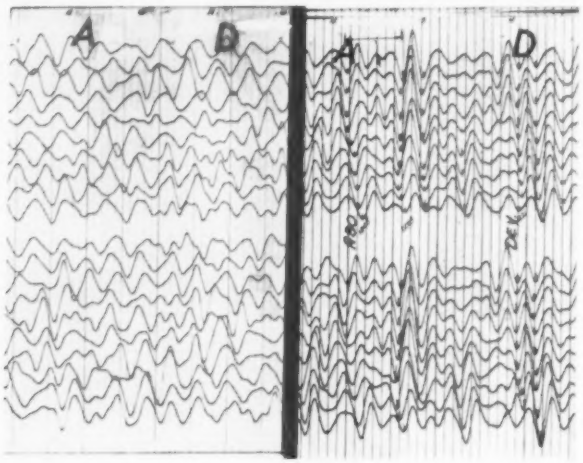

ENLARGEMENT of seismograms shown in Fig. 4. Record at right, made from seven-hole shot-hole pattern, exhibits less interference than record from single hole at left. "B" response is Oswego, and "C" response is the Mississippian limestone. Fig. 5.



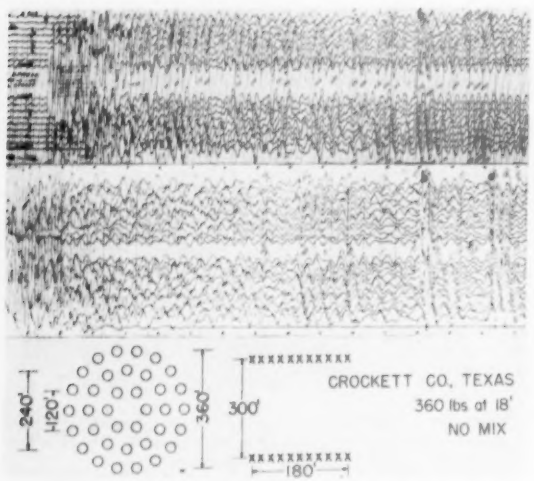

CONTRASTING RECORDS from southeastern Lea County, New Mexico, in the Permian basin. Note six-pointed star type pattern of seismometers for upper record and linear array of seismometers for lower record. Fig. 6.



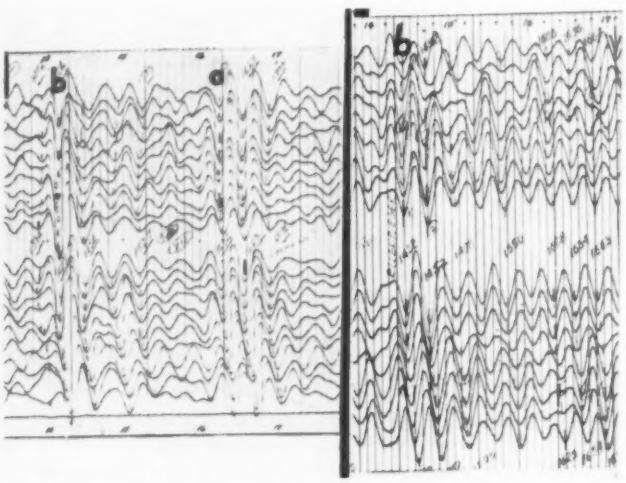

**CONTRAST EFFECTS** in number and array of seismometers using identical ground layout shown in Fig. 6. Upper half of each record has 24 units per trace on star-type pattern of seismometers while lower half carries linear array of 11 seismometers per trace. Fig. 7.




**ENLARGEMENT** of lower record in Fig. 6 and upper record in Fig. 7. Record at right was from 36-hole pattern; left-hand record was from single-hole shooting with one seismometer per trace. Fig. 8.




**EDWARDS PLATEAU, TEXAS,** records in an area where Cretaceous Edwards limestone, up to 500 ft. thick, lies on surface. Two records shot in same manner using circular arrangement of 36 shallow shot holes with 360-lb. shot charge at 18 ft. Fig. 9.




**ENLARGEMENT** of records from Fig. 9. Ellenburger reflection is marked "B"; "A" is a persistently erratic reflection below Ellenburger. Fig. 10.

provement is demonstrated in Fig. 2 for Record D, and the Mississippian portion is enlarged in Fig. 3. Additional improvement is demonstrated by the arrangement of 12 holes in a circular pattern, with the 11-seismometer per trace arrangement. There is no mixing in any of these records.

Fig. 4 shows two records obtained in Harper County, Oklahoma, in the same province as the previous examples, where the top record was obtained with a single hole with 10 lb. at 150 ft. and with five seismometers per trace. The lower record, which shows considerable improvement of all reflections, was obtained with seven holes shot in line with 5 lb. per hole at 60 ft. A, at a record time of 0.75 second, is Pawhuska depth. B, at 1.1 seconds, is Oswego depth, C is the Mississippian, and D the Ordovician.

In Fig. 5 is an enlargement of Fig. 4 showing the Oswego and Mississippian reflections, with the right-hand record being the seven-hole pattern. The seven-hole pattern demonstrates a great deal less interference than the single hole.

The next examples are records from southeastern Lea County, New Mexico, where poor record quality is generally attributed to the caliche surface of the Tertiary system. All of the Lea County examples were made from the same shot point and spread location, with not instrumental mixing.

Portrayed in Fig. 6 at the top is a record obtained with a single hole, 15 lb. at 60 ft., with two cables covering the same surface; one cable employs 24 seismometers per trace as shown on the diagram, and the lower half of the record utilizes 11 seismometers per trace in line. The second record in Fig. 6 is at the same location using the single hole with 25 lb. at 80 ft., and a single seismometer per trace.

In Fig. 7 are two records obtained with the identical layout on the ground with a star-type pattern of seismometers with 24 units per trace on the upper half of each record, and an in-line arrangement of 11 seismometers per trace on the lower half of each record. The top record is a common West Texas multiple-hole pattern of 36 shot holes, each drilled to a depth of 30 ft. and

shot with a total of 180 lb. Dimensions of the pattern are shown in the figure. The lower record, with the same seismometer arrangement, is shot with seven holes with a total of 35 lb. at 60 ft.

Fig. 8 is an enlargement of the lower record in Fig. 6 and the upper record in Fig. 7. The right-hand portion is the 36-hole pattern, and the left-hand of the figure is from a single hole with one seismometer per trace. A on the records is approximately Abo depth with D, Devonian depth. In this particular area, the seven-hole pattern, as shown by the lower record in Fig. 7, is a good record and due to simplicity of pattern, was used for production work.

Fig. 9 shows two records from Crockett County, Texas, area where Cretaceous Edwards limestone lies on the surface. This limestone is very dense and varies from a thickness of 0 to 500 ft. In the past, it was virtually impossible to obtain a normal reflection record in this area. However, in the early 1940's, a large portion of this Edwards Plateau was surveyed with some success using refractions.[1] This figure shows two records obtained in the same manner, both with a circular arrangement of 36 shallow shot holes with a total of 360 lb. shot at 18 ft. In these cases, parallel cables were laid utilizing 22 seismometers per trace.

Seismic technique now employed on the plateau vary considerably as to locality, and as to exact shot-hole pattern arrangement. Also, the seismometer arrangements vary, with probably the most popular arrangement being a star of from 24 to 48 seismometers per trace.

Fig. 10 is an enlargement of the records in Fig. 9, with B being Ellenburger, and A being a persistently erratic, or unidentified, reflection.

In the use of multiple shot holes, hole depths are critical just as they are with a conventional reflection seismograph method. In some areas it is necessary to drill to the unweathered layer to obtain good records, while in other areas it is not required. In any case, where shallow holes are being used in seismic exploration it is very important that adequate weathering determinations be made.

The foregoing illustrations demonstrate marked improvement of seismic record quality and character in three areas by the use of multiple shot holes and multiple seismometers. The pattern arrangements shown are not necessarily those recommended for all areas, but are patterns that have proved to be useful under certain conditions. It should be emphasized also that although these techniques and similar techniques are now giving results in areas that were previously either very, very poor or impossible, the system is by no means a cure-all. There still remain many areas of very poor data, even with these combinations.

### Reference

1. Harris, Sidon, and Gwendolyn Peabody, "Refraction Shooting in West Texas," Geophysics, Vol. II, No. 1 (January 1946) pp. 52-58.

## How to recognize and eliminate

# Certain Types of Record Disturbances

**by J. W. Hammond**

ONE of the prime obstacles confronting a standard seismograph crew in an area of poor record quality is the lack of information regarding the velocity of propagation and frequency of unwanted energy or noise. Some information of this type is necessary if the crew is to make an intelligent approach to the problem of increasing the ratio of reflected energy to noise. Some combination of field procedure and instrumentation must be determined which will provide cancellation or elimination of noise, or provide means for increasing reflected energy without increasing noise.

Author is senior research engineer, Seismograph Service Corp., Tulsa.

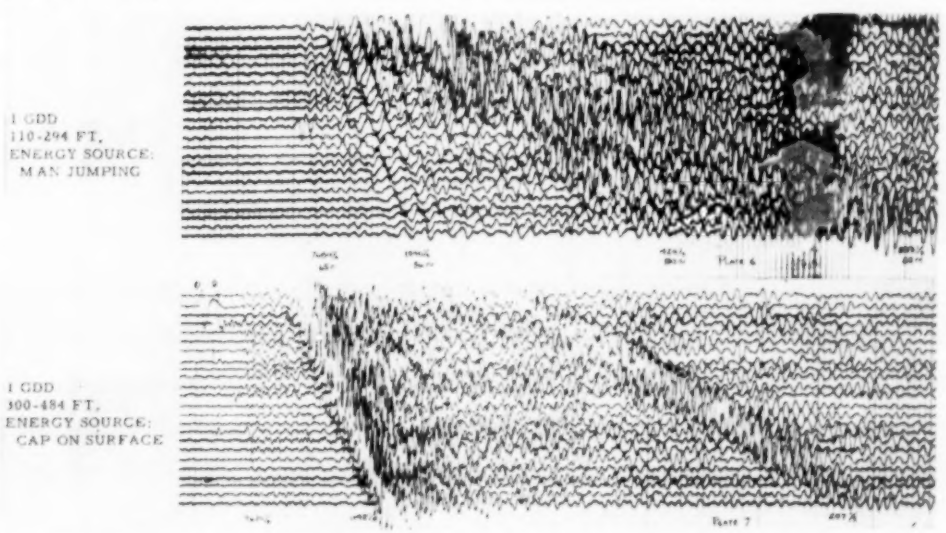



**Fig. 1—Record contrast of wave energies created by cap on surface and man jumping from truck fender to ground.**

Simple tests are available that may be made in any area with standard seismic equipment which will yield valuable information. Fig. 1 shows a test of this type. Geophones were spaced 8 ft. apart to cover 184 ft. of surface.

Upper record is the result of energy generated by a man jumping from the fender of the recording truck to the ground. Energy appears on the record at

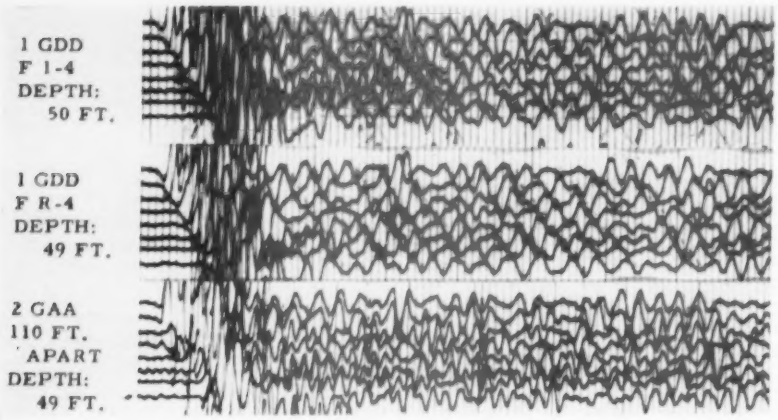



**Fig. 2—Standard seismograms showing first-break refracted energy (P-wave) and secondary refractions. Wave length of interference: 245 ft.**

apparent velocities of approximately 7,680, 1,540, 420, and 253 ft. per second, with apparent frequencies of 67, 36, 50, and 55 cp., respectively.

Energy source for the lower record was a dynamite cap detonated on the surface at a distance of 300 ft. from the end of the spread. Apparent velocities of interference waves recorded are approximately 7,670, 1,142, and 297 ft. per second. The wave traveling at 1,142 ft. per second is the air blast.

The two energy sources discussed above caused a considerable amount of unrest that persisted for an approximate time of 1.5 seconds.

Often the apparent velocity and frequency of interference can be determined from a normal record made on a standard spread. From an analysis of this information on a record, a solution may be made. Fig. 2 shows a record with recurring bursts of energy parallel to the P-wave, or first-break refracted energy. Secondary refractions may be the result of a shot-hole phenomenon similar to the "bubble effect" in water shooting. Wave length of the interference appears to be approximately 245 ft. Two geophones spaced one-half wave length apart were connected in series to obtain the bottom record. Much of the secondary P-wave disturbance is eliminated, although at this stage a usable record has not been obtained.

In every spaced geophone arrangement there will be an attenuation of certain frequencies and an amplification of others; therefore, multiple geophones arranged in line have an effect on the frequency response to horizontally traveling energy and will have an effect on the appearance of the record. Discretion and judgment, therefore, must be used when multiple geophones are utilized to solve an interference problem; otherwise, the results obtained may be negative.

The most desirable method for determining the type of interference present is one of using a flat frequency-response system, such as the variable area recorder and reproducer which Seismograph Service Corp. has been using suc-

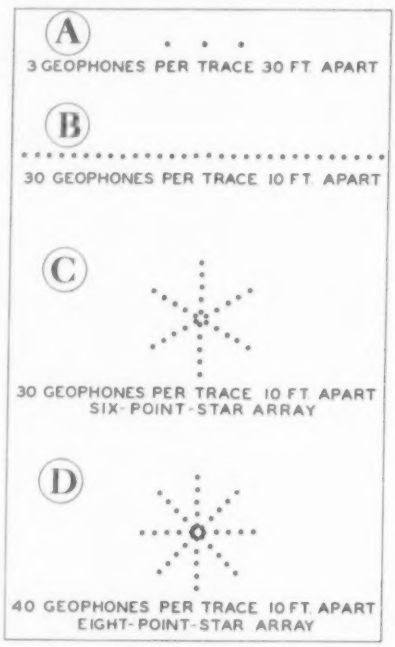



**Fig. 4—Various geophone patterns: (A) 3 geophones per trace, 30 ft. apart, linear arrangement; (B) 30 geophones per trace, 10 ft. apart, linear arrangement; (C) 30 geophones per trace, 10 ft. apart, 6-point-star array; (D) 40 geophones, 10 ft. apart, 8-point-star array.**

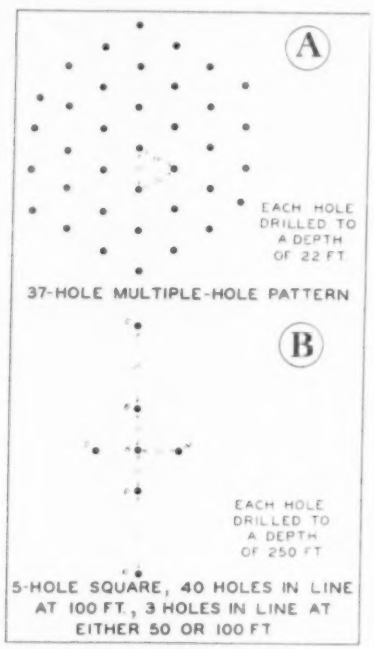

A
EACH HOLE DRILLED TO A DEPTH OF 22 FT.
37-HOLE MULTIPLE-HOLE PATTERN
B
EACH HOLE DRILLED TO A DEPTH OF 250 FT.
5-HOLE SQUARE, 40 HOLES IN LINE AT 100 FT., 3 HOLES IN LINE AT EITHER 50 OR 100 FT

**Fig. 5—Multiple shot hole patterns: (A) 37-hole equally spaced concentric arrangement on 50-ft. centers; each hole drilled to 22-ft. depth. (B) Combination arrangement, four holes in line with 100-ft. intervals, or five spot on 50-ft. intervals; each hole drilled to 250-ft. depth.**

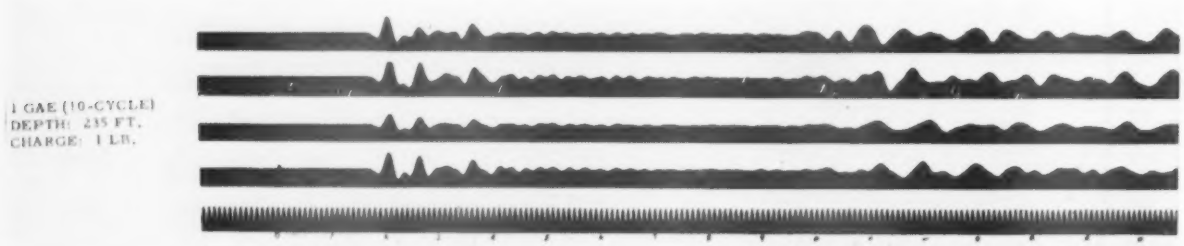



**Fig. 3—Variable area record from flat response system from average prospect. Major peaks and troughs result from high energy noise. High amplitude energy wave length is 25 ft.; 14-cp. wave front moving at average velocity of 346 ft. per second.**

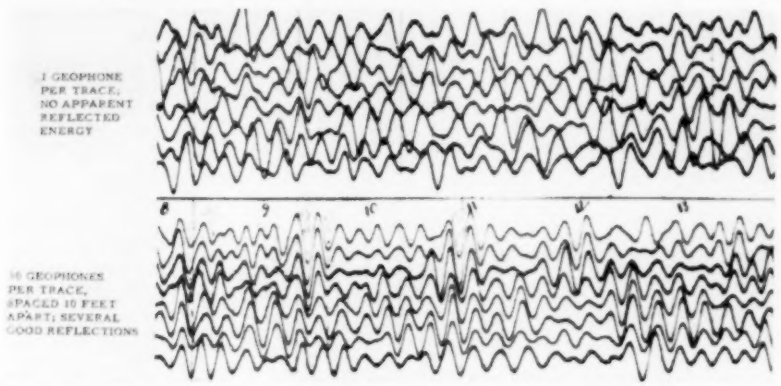

1 GEOPHONE PER TRACE, NO APPARENT REFLECTED ENERGY
30 GEOPHONES PER TRACE, SPACED 10 FEET APART; SEVERAL GOOD REFLECTIONS

**Fig. 6—Record quality contrast: Top record, employing 1 geophone per trace, shows no apparent reflected energy; bottom record, employing 30 geophones per trace, shows several excellent reflections. Records were recorded simultaneously.**

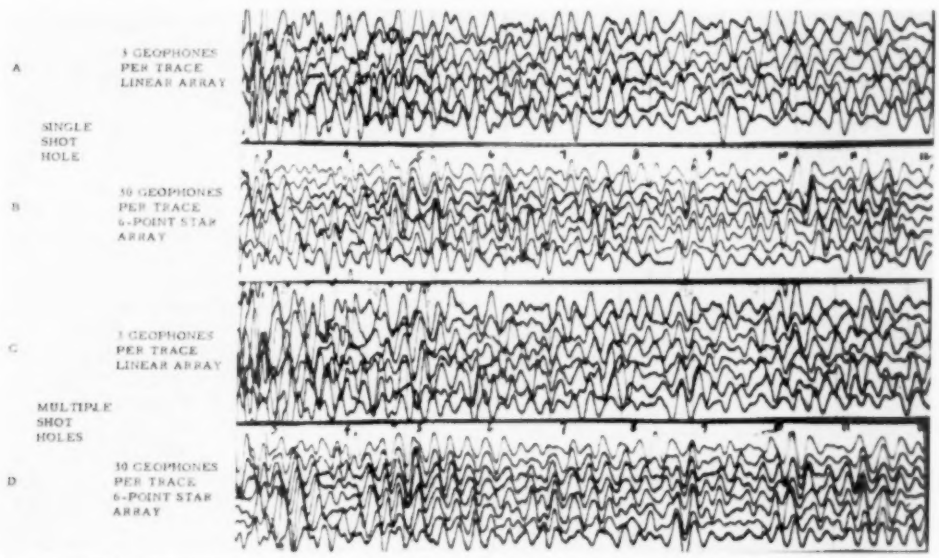



**Fig. 7—Record improvement example: top seismograms compare linear versus six-point-star array for single-hole shot point; bottom records compare linear versus six-point star array for multiple shot holes. Results: (A) no definite reflected energy; (B) some poor reflections; (C) some reflections; (D) several good reflections.**

cessfully for 12 years. Fig. 3 shows a typical variable area record from this flat response system obtained from an average prospect. The major peaks and troughs are the result of high-energy noise and not reflected energy; i.e., the high-amplitude energy traversing the record at a record time of 1.10 seconds represents a 14 cp. wave front traveling at a velocity of 346 ft. per second and having a wave length of 25 ft. Through the use of the flat frequency-response record, an accurate determination of frequency, velocity, and wave length of the interference can be made, from which multiple shot-hole patterns and multiple geophone arrays can be designed.

A few of the geophone arrays and shot-hole patterns used to produce the following examples of record improvement are shown in Figs. 4 and 5.

An example of record improvement from a single shot-hole through the use of multiple geophones in an area of predominately high-frequency random noise is shown in Fig. 6. The top record was obtained from a single geophone per trace, with no reflected energy apparent. The bottom record was made from 30 geophones per trace, spaced 10 ft. apart in line of profile (Fig. 4, No. 2). Frequency response of the GEA and GAA geophones is similar, and the two records were recorded simulanteously. There was an overlap between adjacent geophone arrays of approximately 50 per cent. Several good reflection alignments are indicated on the multiple-geophone record.

An example of record improvement through the introduction of both multiple holes and multiple geophones is shown in Fig. 7. The plate also shows a comparison of 3 geophones per trace, spaced at intervals of 30 ft. (Fig. 4, No. 1), versus 30 geophones per trace

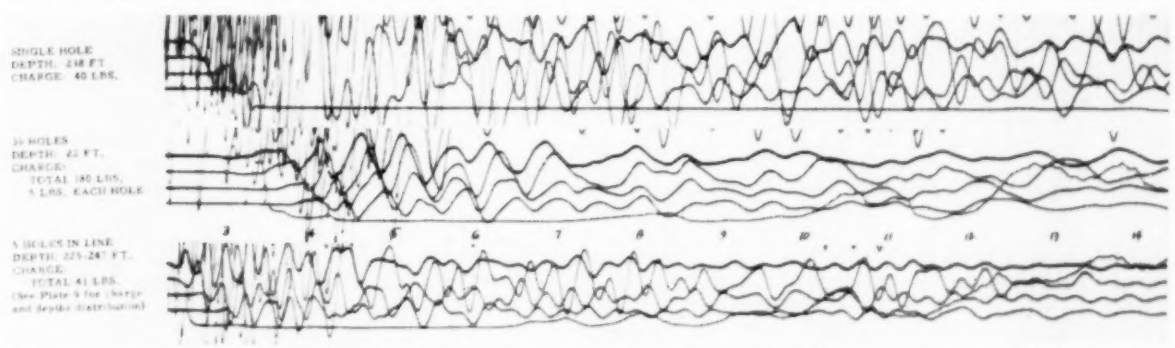



**Fig. 8—Interference-reduction example through use of multiple shot holes as recorded through flat frequency-response system. Gain settings set constant at 50 db. Results: (A) very high amplitude disturbance; (B) lower-level high-frequency energy but higher-level low-frequency intervals; (C) considerably reduced noise level.**

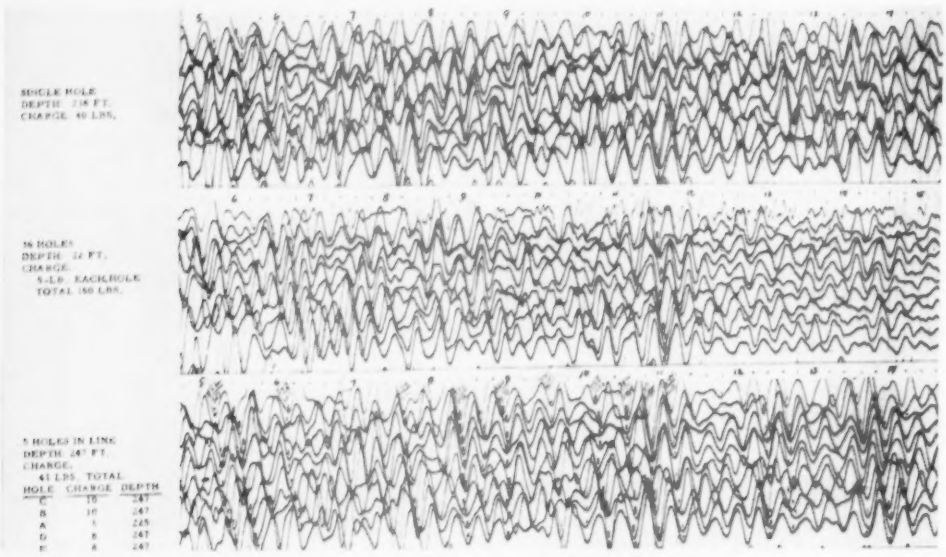



**Fig. 9—Effect of shot-hole depth and number of shot holes on record quality. Middle record (B), employing 22-ft. holes and multiple geophones, has fair trace alignment. Record A, made from single deep hole with multiple geophones, has very poor trace alignment, while Record C, employing five deep holes in line and multiple geophones, carries a series of good reflection alignments.**

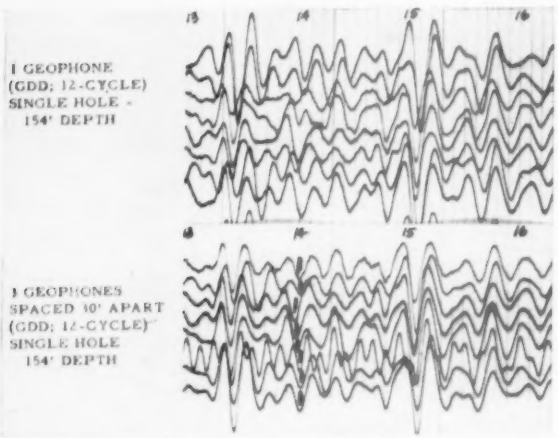



**Fig. 10—Alignment improvement by use of multiple geophone array to record a weak reflection at 1.4 seconds. Charge: 50 lb.**

located in a six-pointed-star array, each geophone separated by 10 ft. from any other (Fig. 4, No. 3). The upper record, made using a charge of 5 lb. in a single shot hole with three geophones per trace, has no definite reflected energy present. The second record, made using a single shot hole with the array of 30 geophones per trace, indicates some poor reflection alignments. The third record, made while using a total of 5 lb. of dynamite, equally distributed in a square pattern of four shot holes (Fig. 5, No. 2, shot points B, N, D, and S) with three geophones per trace, has some reflection alignments of very poor quality. The bottom record, made using the pattern of 4 shot holes and 30 geophones per trace, has several good reflection alignments. The upper record and the second record were made simultaneously, as were the third and fourth records.

The next example, Fig. 8 shows the reduction of the interference through the use of multiple holes, as recorded through the flat-frequency response system. Gain settings were held constant for the following tests. The top record was made using a 40-lb. charge placed in a single hole at a depth of 238 to 250 ft. A very high-amplitude disturbance was recorded, frequencies of which varied from 14 to 35 cp. The second record, which was made using 37 holes located in a circular pattern (Fig. 5, No. 1), each hole being 50 ft. from adjacent holes and each loaded with a 5-lb. charge of dynamite at a depth of 22 ft. (total charge 185 lb.), indicates a lower level of high-frequency energy, but a higher level of low-frequency interference. The third record, which was made from a charge of 40 lb. of dynamite distributed among five shot holes (Fig. 5, No. 2, shot holes C, B, D, A, and E) in line of profile and at depths of 225 and 247 ft., carries a much lower noise level.

Corresponding records made simultaneously with conventional instruments are shown in Fig. 9. Forty geophones per trace in an eight-pointed-star pattern (Fig. 4, No. 4) were used, with a 10-ft. interval between geophones. Top record, made from a single hole, has very poor trace alignments indicated. Second record, made using the 37-hole pattern of shallow holes, has fair trace alignments, but they are poorer in quality than those obtained from the pattern of five deep holes. The third record, made from the five-hole pattern of deep holes, has good reflection alignments throughout the entire length of the record.

Record improvement through the use of multiple geophones is not necessarily accomplished only by cancellation of interfering energies, but may also be obtained by improvement of the average geophone plant gained from the additional geophones. Fig. 10 shows a comparison of a single geophone versus three geophones per trace, spaced 30 ft. apart. The multiple-geophone array was used in an attempt to record a weak reflection at a record time of 1.4 seconds. Alignment was improved by the use of the three geophones. Minor improvement is noted throughout the portion of the records shown, and is probably not important, insofar as the two major reflections are concerned. Improvement in reflection follow-through on the 1.4 reflection, however, means the difference between reliable data and questionable data.

Thus, it is evident that multiple geophones, when properly spaced, will reduce the interfering energy. Likewise, multiple holes improve the signal-to-noise ratio. The combination of both will give further improvement and, under difficult conditions, may be necessary to obtain usable reflections. The use of a flat frequency-response system permits an analysis to be made of the interference, from which analysis a logical selection of the multiple geophones and the multiple holes can be made, thereby assuring satisfactory records not otherwise obtainable.

SYMPOSIUM . . . PATTERN SHOOTING

# DESIGN FACTORS

## . . . for multiple arrays of geophones and shot holes

. . . must be carefully considered to secure desired results with reasonable number of units

**by F. F. Reynolds**

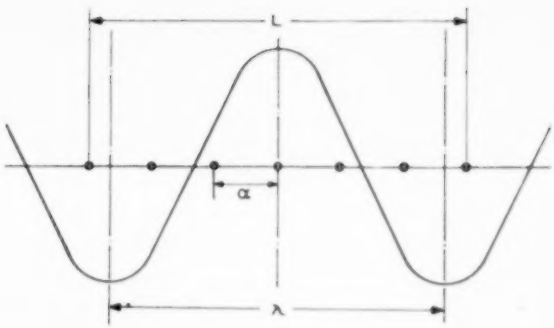



Fig. 1—Maximum response occurs when the sine wave is symmetric about the geophones.

THE present use of multiple arrays of geophones and shot holes in seismic reflection work represents an effort by the geophysicist to secure usable data in so-called "no reflection" areas.

Seismic reflection records in these areas are characterized by random energy originating with the shot, and of such a level as to completely obscure the reflected events.

In order to obtain dependable data, resort has been made to the use of areal arrays of geophones and shot holes. These arrays reinforce the reflected energy and by cancellation, minimize random noise originating with the shot. This random noise is composed of pulses having a time duration comparable to a reflection pulse, and of segments of waves which appear to be of a reasonably continuous nature.

In the instance of a pulse having a time duration sufficiently short so that only one geophone is affected at any one time, the response of a system of N geophone is 1/N.

For a system being constantly subjected to a series of short pulses, Klipsch[1] has shown the average gain in signal-to-noise ratio is approximately:

$$G = 1.13\ (N)^{1/2}$$

Author is with Seismic Explorations, Inc., Houston.

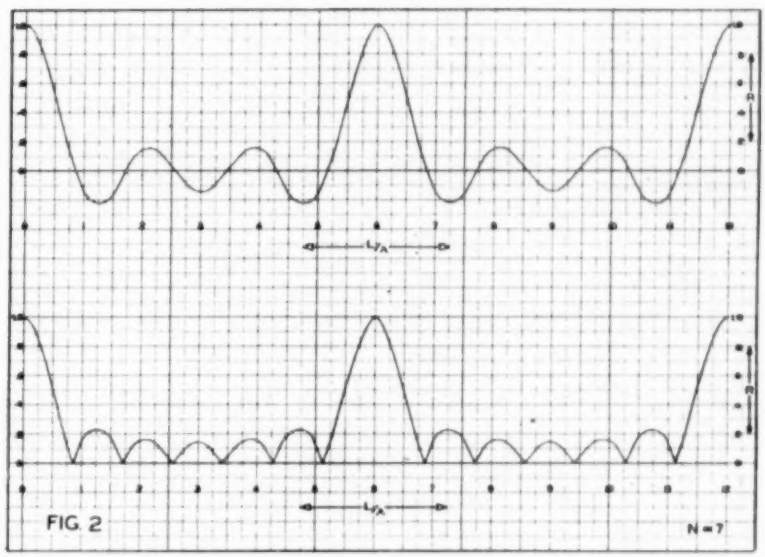



Fig. 2—Response of the system shown in Fig. 1 is unity when L/λ is zero.

**System geometry . . .** If the random noise is composed of continuous waves, then the geometry of the system becomes important, and the successful use of multiple arrays requires an understanding of this geometry.

In the ideal case of a simple wave progressing along the surface, two geophones, spaced one-half wave length apart, will cancel the effect of the wave motion. Unfortunately, the background noise consists of energies whose apparent wave length varies over a wide range. A practical solution requires the development of a system which will reject a wide band of wave lengths.

Assume a linear array of N geophones, uniformly spaced over a total

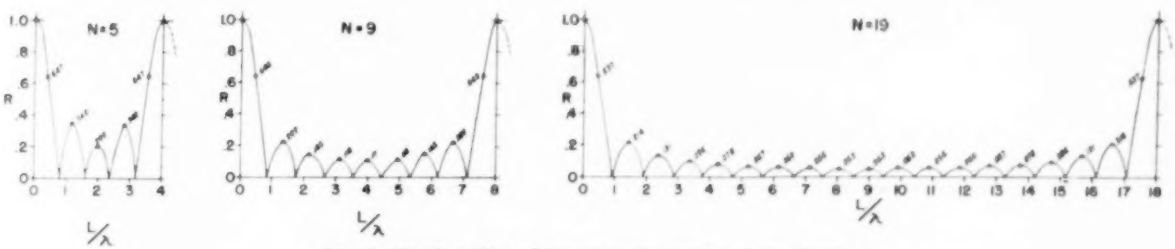



Fig. 3—Showing effect of increasing the number of geophones.

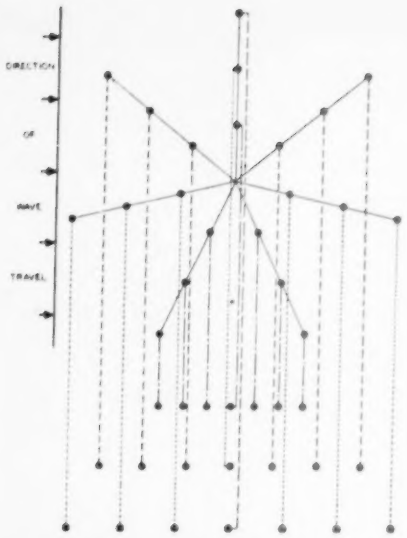



Fig. 4—Geophone pattern which minimizes "lumping."

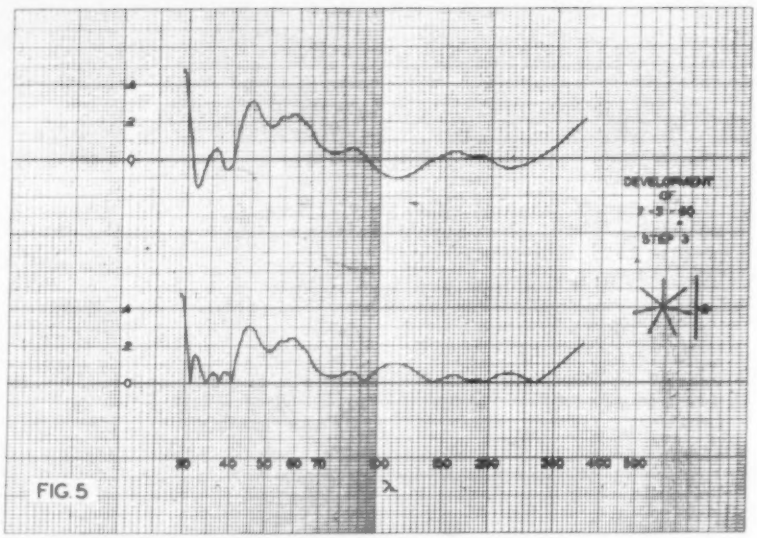



Fig. 5—Response of the 7-3 geophone pattern shown in Fig. 4.

## Symposium . . . Pattern Shooting

distance L. These geophones are alike in every respect and are electrically connected so that the output of the array is the vector sum of the outputs of the individual geophones.

The problem is to compute the maximum response of such an array to a continuous sine wave of wave length λ. This maximum response occurs when the wave is symmetric about the array (Fig. 1), and the value of this maximum response R, in terms of the ratio to reflected energy, is:

$$R = \frac{\text{Sin } N\,\theta}{N \text{ Sin } \theta}$$

where:

$$\theta = \frac{360\,L}{2\lambda\,(N-1)}$$

A plot of this equation in terms of R and the ratio of $L/\lambda$, for N = 7, is illustrated in Fig. 2. It will be noted the response of this system is unity when $L/\lambda$ is zero (the condition for reflection). It is also unity when:

$$L/\lambda = \frac{L}{N-1}, \frac{L}{2(N-1)}, \frac{L}{3(N-1)}, \text{ etc.}$$

Between these major maximums there are well-pronounced minimums whose value is determined by the number of geophones in the array. This number also controls the spacing of the major maximums.

The effect of increasing the number of geophones is illustrated in Fig. 3, wherein are shown plots of absolute amplitudes for N = 5; N = 9; N = 19. This figure clearly illustrates the broad band of low response which occurs when a large number of equally spaced geophones is employed.

The foregoing suggests that the geometry of the linear array be such that these successive major maximums lie outside the spectrum under consideration and that a reasonably large

*(Continued on page 195)*

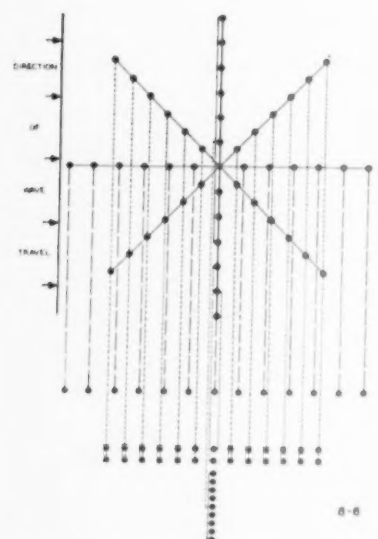



Fig. 6—Geophone pattern which does not minimize "lumping."

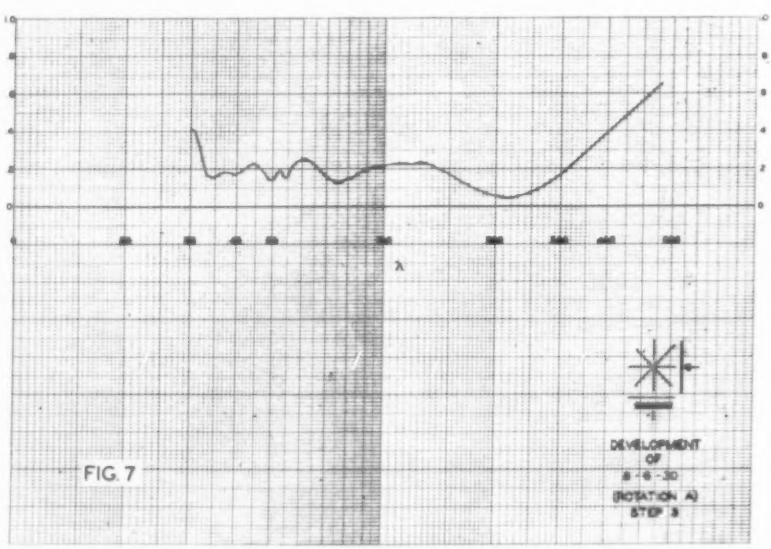



Fig. 7—Response of the 8-6 geophone pattern shown in Fig. 6 (compare with Fig. 5).

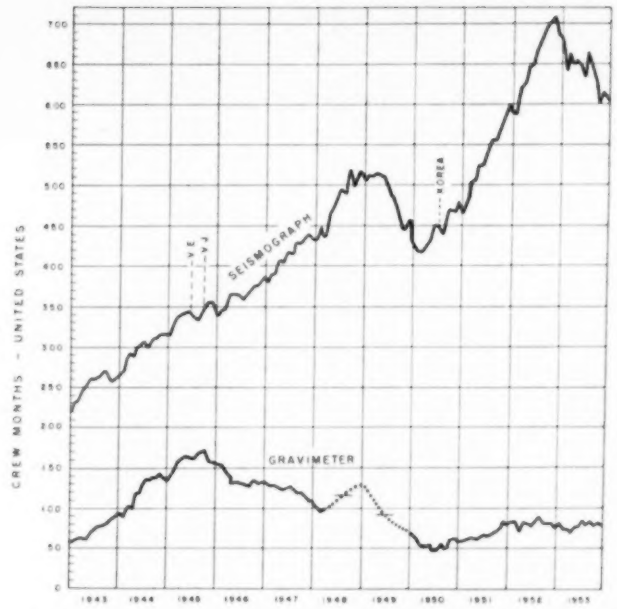



Fig. 1—Monthly variations in seismograph and gravimeter crew-months in the United States.

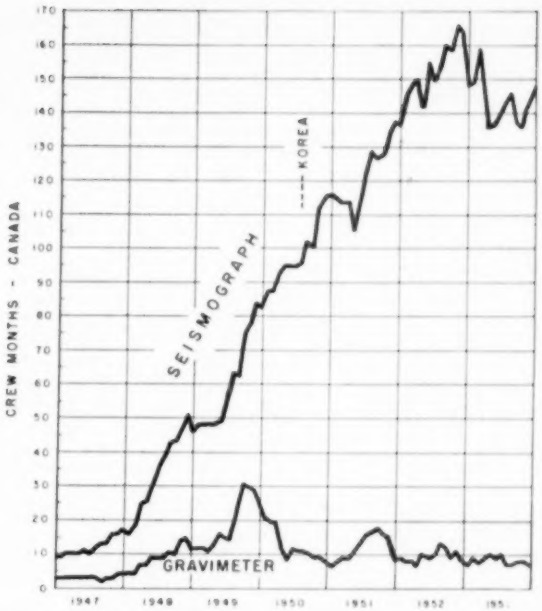



Fig. 2—Monthly variations in seismograph and gravimeter crew-months in Canada.

# Geophysical Activity Drops in U.S., Canada

## . . . but globally maintains 1952 record peak

"Indiscriminate leasing and drilling, without the best geological and geophysical guidance that can be brought to bear, can only be expected to diminish the effectiveness of exploration and raise discovery costs."

**by Sigmund Hammer**

GEOPHYSICAL activity in the search for oil in 1953 on a global scale maintained but probably did not exceed the record high established in 1952. Increased activity occurred in Mexico, in South America, and in Africa and the Far East. These increases offset small but definite declines in geophysical activity in the United States and in Canada.

**World summary . . .** The over-all world-wide effort in 1953 utilized the full-time services of 1,100 geophysical crews. This figure is slightly higher than for 1952 but includes other methods which were not reported the previous year. The crews were distributed among the various geophysical methods as follows: seismic 941, gravity 129, magnetic 19, and others 16. Comparative data reported for 1952 were seismic 948, gravity 125. World-wide seismic operations in 1953 were lower than in 1952 by an average of seven crews; gravity operations were up four crews. Comparative data are not available for magnetic and other methods.

In the United States and Canada, the total number of seismic crew-months totaled 9,379, down 422 or 4.3 per cent. This represents a substantial loss of the full-time services of 35 seismic crews. Gravity totaled 1,048 crew-months, down 27 (2.5 per cent) or about 2 fewer crew-years.

The month-by-month fluctuation of seismograph and gravity operations in the United States is shown for the 10-year period up to the end of 1953 in Fig. 1. The very sharp decline in seismic activity which began in October 1952 was slowed but continued the downward trend through 1953. The number of seismic crews in the field at the end of the year was 612. Gravity operations in the United States continued at a relatively constant rate. The number of gravimeter crews in operation at the end of the year was 80.

The month-by-month fluctuation of field crews in Canada is shown in Fig. 2. The similarity to the curves for the United States is remarkable. However, it is noteworthy that gravity work in Canada suffered a gradual decrease during 1953; whereas, the seismic work, after a sharp drop in the first quarter, fluctuated about a level average during the last three quarters and showed a definite sharp rise at the end of the year.

**Williston activity shifts . . .** The geographic distribution of 1953 United States seismic operations is shown in Fig. 3. Again, as for the first time last year, Texas and Louisiana together account for slightly less than one-half of the total activity. The concentration of work in the Rocky Mountain area continued through 1953 but a major shift occurred in the Williston basin from North Dakota into Montana. Seismic work in North Dakota decreased 91 crew-months, a drop of 21 per cent. In Montana the increase was 163 crew-months, up 28 per cent. Other large changes were in Texas—

**Fig. 3—Distribution of 1953 seismograph operations in the United States.**

**Fig. 4—Distribution of 1953 gravimeter operations in the United States.**

down 211 crew-months or 8 per cent—and in Louisiana—up 185 crew-months or 17 per cent. Substantial decreases were also recorded in California, New Mexico, and Colorado. A definite increase occurred in Wyoming. Other changes and shifts of seismic operations in the United States are listed in Table 1.

**Gravimeter . . .** The areal distribution of 1953 gravimeter operations in the United States is shown in Fig. 4. More than half, nearly 60 per cent, of all gravity work in the United States was shared between Texas and Louisiana. More than half of the remainder was in the Rocky Mountain area. Substantial amounts of gravity work was also done in California and in the Southeastern States. As with seismic work, a major shift of gravity activity was made in the Williston basin out of North Dakota into Montana. Declines in gravity work occurred in California, Oklahoma, New Mexico, and Mississippi. Substantial increases took place in Colorado, Texas, and Louisiana. Additional information on areal distribution and shifts of gravity operations in

**TABLE 1—SEISMOGRAPH CREW-MONTHS IN UNITED STATES**

| State— | 1952 | 1953 | Per cent change |
|---|---|---|---|
| Texas | 2,670 | 2,459 | — 8 |
| Louisiana | 1,083 | 1,268 | +17 |
| Mississippi | 203 | 191 | — 6 |
| Oklahoma | 411 | 404 | — 2 |
| New Mexico | 657 | 600 | — 9 |
| Colorado | 252 | 216 | —14 |
| Wyoming | 519 | 543 | + 5 |
| Montana | 574 | 737 | +28 |
| North Dakota | 436 | 345 | —21 |
| California | 283 | 229 | —19 |
| Other | 870 | 674 | —22 |
| Total | 7,948 | 7,666 | — 3.7 |

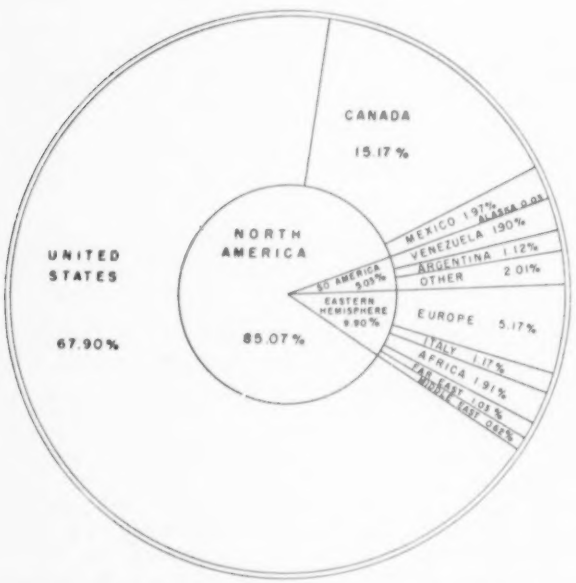



**Fig. 5—World distribution of seismograph operations in 1953.**

**Fig. 6—World distribution of gravimeter operations in 1953.**

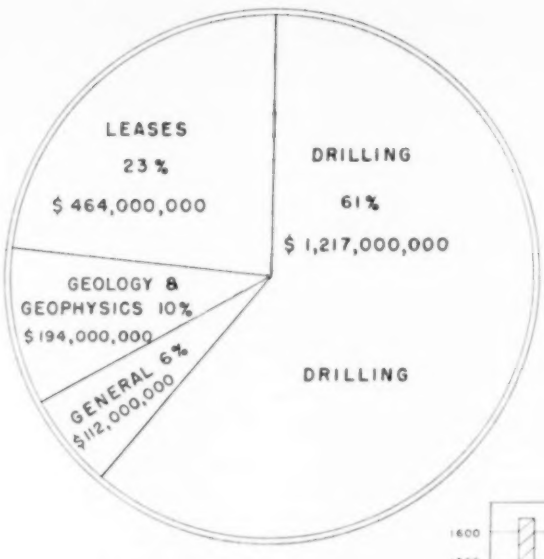



Fig. 7—Expenditures for geology and geophysics is a small fraction of high petroleum exploration costs.

## THE AUTHOR

**Dr. Sigmund Hammer, Gulf Research & Development Co., Pittsburgh, is chairman of the committee on geophysical activity of the Society of Exploration Geophysicists. The members of this committee are: A. A. Brant, Herbert Hoover, Jr., Kumiji Iida, A. Garcia Rojas, Raoul Vajk, and Dr. Hammer.**

**The accompanying report was presented at the St. Louis meeting of the society, April 12-15, 1954.**

the United States is given in Table 2.

**TABLE 2—GRAVITY CREW-MONTHS IN UNITED STATES**

| State— | 1952 | 1953 | Per cent change |
|---|---|---|---|
| Texas | 381 | 387 | + 2 |
| Louisiana | 153 | 174 | +14 |
| Mississippi | 57 | 51 | −10 |
| Oklahoma | 13 | 3 | −77 |
| New Mexico | 54 | 47 | −13 |
| Colorado | 19 | 30 | −58 |
| Wyoming | 30 | 30 | None |
| Montana | 72 | 94 | +30 |
| North Dakota | 43 | 3 | −93 |
| California | 89 | 69 | −22 |
| Other | 54 | 61 | +13 |
| Total | 965 | 949 | − 1.7 |

**Seismic . . .** World distribution of seismic explorations for petroleum is shown in Fig. 5. Two-thirds of all seismic activity was in the United States. Canada ranked second with slightly less than one-sixth of the world total. Including substantial operations in Mexico and some in Alaska, the North American Continent accounted for 85 per cent of all seismic activity in petroleum exploration during 1953. A considerable amount of seismic work was also reported in the Eastern Hemisphere, about one-tenth of the world total. About half of this work is credited to Europe, with Africa, Italy, the Far East, and the Middle East following in that order. About 5 per cent of the world seismic effort during 1953 was in South America, with Venezuela and Argentina the principal participants.

The world distribution of gravimeter operations is shown in Fig. 6. The United States accounted for 949 crew-months or over 61 per cent of the total. Canada, as a single nation, ranked second with a total of 99 crew-months or 6.4 per cent of the world total. Africa and Mexico followed with 69 and 48 crew-months each, respectively. North America, taken as a whole, did 1,096 crew-months of gravity work or 70.75 per cent of the world

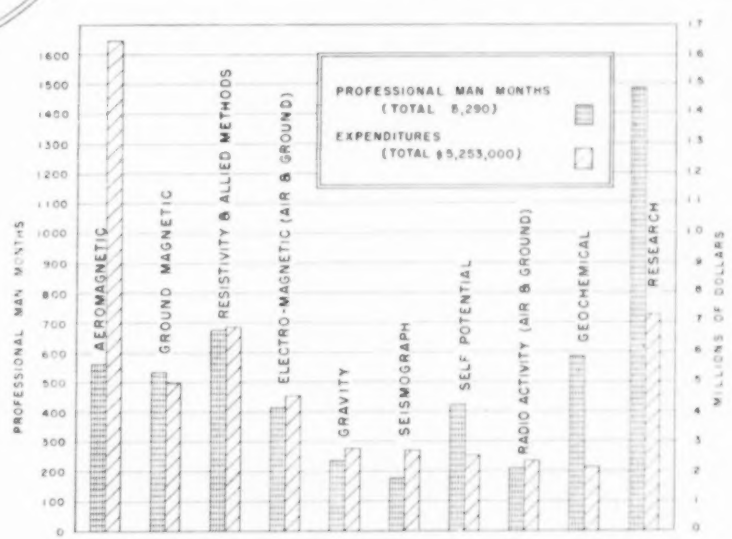



Fig. 8—Mining geophysics—world-wide effort in 1953 by methods.

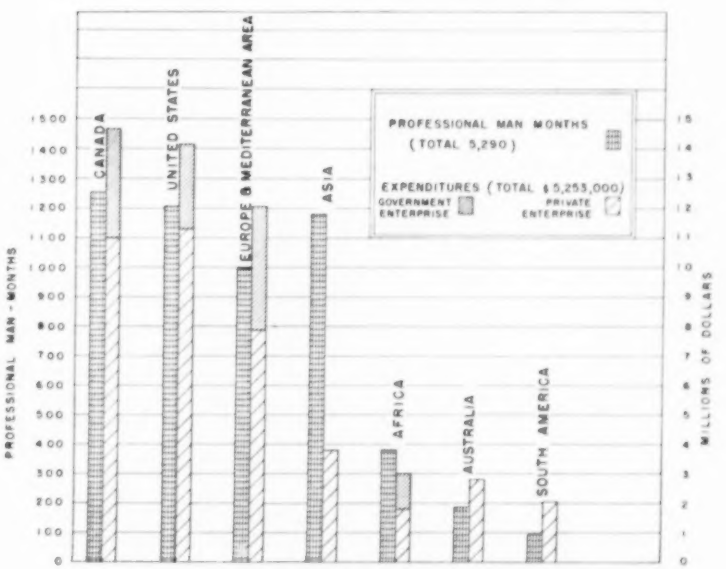



Fig. 9—Mining geophysics—world-wide effort in 1953 by areas.

total. In South America, the total was 144 crew-months, 9.3 per cent of total. A substantial amount of gravity work was reported in the Eastern Hemisphere—a total of 309 crew-months or one-fifth of the world total.

**Magnetic . . .** Magnetic exploration is apparently staging a comeback. This is, of course, largely due to the many advantages of the airborne magnetometer. However, a relatively great amount of ground magnetic work was also reported. In the United States and Canada, a total of 70 crew-months of magnetic work was reported. Of these, it can be estimated that about 30 crew-months were airborne, with an output of about 200,000 miles of continuous aeromagnetic profile. South America reported 83 magnetometer crew-months and the Eastern Hemisphere 73 for a world total of 226 magnetometer crew-months.

**Offshore . . .** Explorations on the Continental shelves and other offshore areas continued active. Totals of 102 waterborne seismic crew-months, 27 underwater gravimeter crew-months, and 3 offshore aeromagnetic crew-months were reported. About three-quarters of this activity was in the Gulf of Mexico, offshore Texas, Louisiana, and Florida. The remainder was offshore California and Trinidad and in the Persian Gulf.

**More geophysics needed . . .** The investment by the oil industry of the world in geophysical exploration during 1953 probably was on about the same level as in 1952, namely $350,000,000 to $400,000,000. The slight decline in seismic activity, which accounts for about 90 per cent of the total cost, was probably offset by small increases in unit costs.

The decline in the use of geophysical tools by the petroleum industry in the search for new oil fields in the United States and Canada during the past year is a matter of serious concern. The effectiveness of the geophysical methods has been proved beyond doubt by the results of wildcat drilling. Recasting Lahee's data[1] into a slightly different form, we find that the chance for discovering a new oil field by wildcat drilling depends upon the basis for choosing the site according to Table 3.

**TABLE 3—DISCOVERY EFFECTIVENESS OF NEW-FIELD WILDCATS—U. S. AVERAGE 1949-1953**

| Basis of location— | Success ratio |
|---|---|
| Nontechnical | 1 in 27 |
| Technical | 1 in 6 |

These data show that the use of geophysics improves the chance for success of a new-field wildcat compared to random drilling by a factor of 450 per cent. The cost of this major improvement, while it represents a very large number of dollars, is a relatively minor factor among the other over-all huge exploration costs. A breakdown of these cost factors by H. J. Struth[2] is illustrated in Fig. 7. The segment allocated to geology and geophysics taken together (Struth's data do not report them separately) is actually less than 10 per cent of the total exploration cost. Leasing and drilling, both of which are vitally dependent upon geology and geophysics for high effectiveness, account for 84 per cent of exploration costs. The petroleum industry is sharply aware of steeply rising oil-discovery costs. These considerations show that what is needed is not less but more and better geophysics. Curtailment of competent geophysical effort, of proved effectiveness, cannot be recommended or condoned as a sound, long-range business policy to attain effective exploration and low oil-finding costs.

Indiscriminate leasing and drilling, without the best geological and geophysical guidance that can be brought to bear, can only be expected to diminish the effectiveness of exploration and raise discovery costs. It is to be hoped that the downward trend in geophysical activity will be reversed promptly and decisively.

Reported plans call for the drilling of over 11,000 wildcats in the United States in 1954. As members of the exploration team and as geophysicists, it is our professional responsibility to place as many as possible of these wildcats in the most effective category in Table 3.

### Geophysical Activity in the Mining Industry

Mining geophysics—the applications of geophysical methods in explorations for solid minerals—was maintained at nearly the same over-all level both in amount of capital invested and in utilization of professional manpower.

The reported data are summarized in the accompanying Figs. 8 and 9.

### Figures 8 and 9

Two measures are shown: (1) utilized professional man-months and (2) expenditure converted into United States dollars. The reported expenditure in 1953 of more than $5,000,000 sets a record in the applications of mining geophysics. The utilization of a total of 5,290 professional man-months is also a new high.

The distribution of geophysical effort in mining among the different methods during 1953 is shown in Fig. 8. The application of the magnetic method and especially of the areomagnetic method lead all others. Resistivity and allied electrical methods were second. The rank of the remaining methods depends upon the measure used. On the basis of applied manpower, the decreasing order was (3) geochemistry, (4) self-potential, (5) electromagnetic, (6) gravity, (7) radioactivity, and (8) seismic. On the basis of expenditure, the decreasing order was (3) electromagnetic, (4) gravity, (5) seismic, (6) self-potential, (7) radioactivity, and (8) geochemistry.

The distribution of geophysical exploration effort during 1953 in the various countries of the work is shown in Fig. 9. Canada has a slight lead over the United States for first place. Europe, Asia, Africa, Australia, and South America follow in that order.

Comparison of the statistics for 1953 with those for 1952 is subject to some uncertainty due to suspected icompleteness of reports. Accepting the available data at face value, it appears that minor increases in applications were recorded in the electrical and gravity methods and that the use of the various techniques of geochemistry increased substantially during 1953.

Exploration for uranium is attracting much interest.[3] A recent development is the use of Geiger counters and scintillometers to check seismic shot holes and slush pits for interesting radioactive indications. Several sources report a total of 506 seismic shot holes, covering a drilled section of 65,000 ft., tested by this method.

Evaluating the utility of geophysics in mining exploration is still at an early stage. Considerable reluctance to publish or even to announce findings based on geophysics continued to be apparent. However, it is encouraging that technical papers and especially case histories of mining geophysics are becoming increasingly available for publication. We are especially pleased that an entire session of the S.E.G. program at this meeting is being devoted to technical mining-geophysics papers including case histories of important geophysical discoveries. This is most encouraging. The free exchange of technical experiences, involving the accumulated investments of some tens of millions of dollars, can hardly fail to expedite higher professional achievements and speed the benefits to the industry as a whole.

### References


1. F. H. Lahee, "Exploratory Drilling in 1952," A.A.P.G. Bulletin, June 1953. Data for 1953 were kindly furnished by Dr. Lahee in a personal communication.

2. H. J. Struth, "Oil Finding Cost . . .", Petroleum Engineer, May 1953.

3. For further information contact Joint Advisory Committee of A.A.P.G., S.E.G., S.E.P.M. on Radioactive Mineral Exploration, Dr. F. H. Lahee, chairman, Box 2880, Dallas.

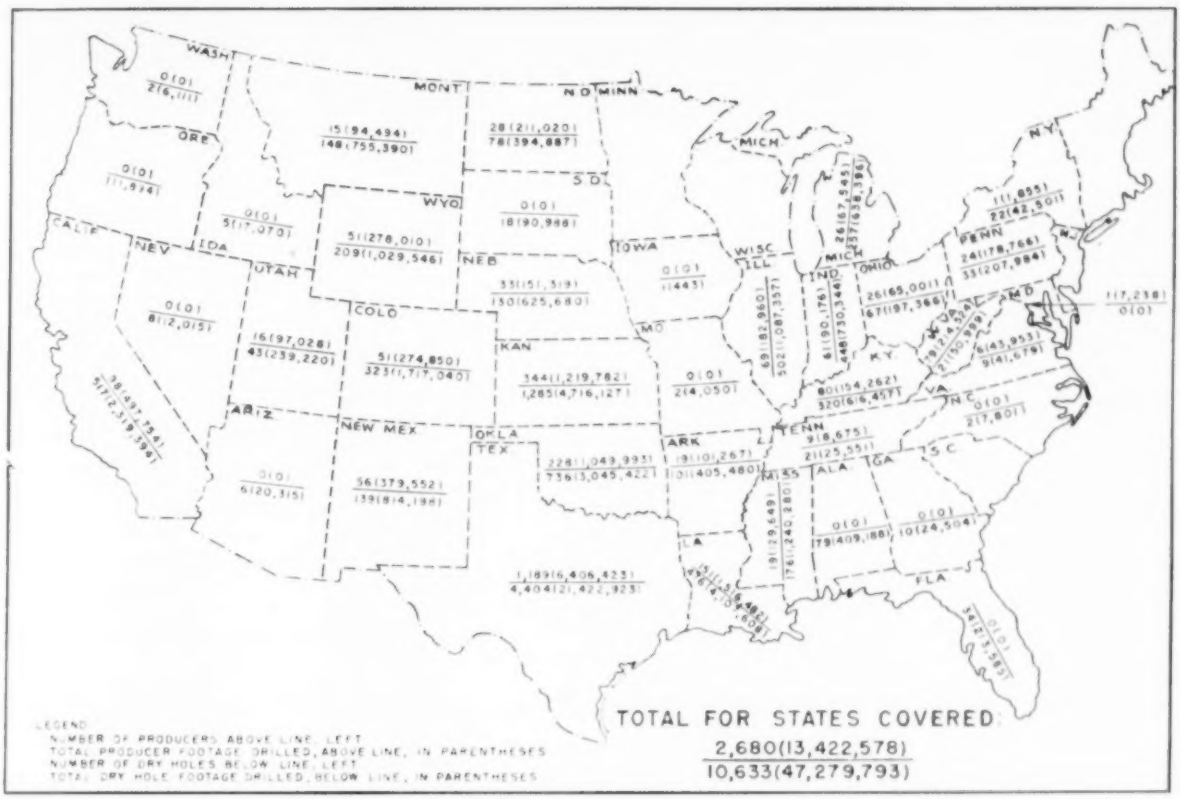



Fig. 1—Where hole was made in 1953 in the United States in the search for new oil.

## 1953 EXPLORATORY DRILLING . . .

# 13,313 Wildcats Probe for New Oil

### Hits, Runs, and Errors . . . The Box Score

- 2,680 producers drilled to 13 million feet
- 10,633 dusters drilled to 47 million feet
- One hit to every 3.98 misses
- One producer foot to every 3½ ft. of duster.

**by Frederic H. Lahee**

**This abridgement of the report of the chairman of the American Association of Petroleum Geologists' Committee on Exploratory Statistics, presented at the association's annual meeting in St. Louis, April 12-15, is published by special permission of the author and the A.A.P.G. The full report will be published in the June bulletin of the A.A.P.G.**

IN the states covered in this review, as shown in Fig. 1 and listed in Table 2, during 1953 a total of 60,702,371 ft. was drilled in 13,313 exploratory holes, divided as follows:

| | |
|---|---|
| 2,680 producers | 13,422,578 ft. |
| 10,633 dry holes | 47,279,793 ft. |

This means that 20.13 per cent of the holes drilled, and 22.11 per cent of the footage drilled, were successful in 1953. One producer foot was drilled for every 3.52 ft. of dry hole. One successful well was drilled for every 3.98 dry holes. The average depth of hole was 4,560 ft.

Attention is called to the average depth figures for the various producing classes and for dry holes, and totals, at the bottom of the footage columns in Table 2.

**Bases for drilling . . .** In Table 3 are listed the reasons for drilling the new-field wildcats in 1953, by using the best information available from men familiar with such statistics, each in his own state or district. According to these figures 689 new-field wildcats drilled on technical advice (geology and/or geophysics) were successful, and 5,058 were dry; 21 holes, located for nontechnical reasons, were producers, and 426 were dry; 64 producers and 667 dry holes were located for reasons unknown. These figures show that 11.9 per cent of the new-field wildcats drilled on technical advice were producers as contrasted to 4.7 per cent successful in the case of holes located without technical advice. Therefore, in 1953, locations for new-field wildcats based

on technical recommendations were two and one-half times as successful as those drilled without such advice. Seismographic methods were largely responsible for 340 producers and 1,745 dry holes, among the new-field wildcats.

Table 4 will be of interest to our readers for it shows the relative success, as measured by the number of producers in comparison with the number of dry holes, in each year from 1944 to 1953, inclusive.

The same data for all exploratory holes are graphically shown from 1938 to 1953 in Fig. 3.

**Classifications . . .** As indicated in Table 1, a hole may be located as an outpost with the intention of trying to extend a pool partly developed, but instead it may discover a new pool; and, similarly, a new-pool wildcat may be located in search of a new pool because it is believed to be well outside the limits of the known pool, but instead it may result in extending this known pool farther than had been expected. A majority of outposts, if successful, are completed as extension wells and a majority of new-pool wildcats, if successful, discover new pools.

A question sometimes asked concerns the approximate percentage of true wildcatting (new-field wildcatting) by major companies, on the one hand, and by minor companies and independents,

**TABLE 1—CLASSIFICATION OF EXPLORATORY WELLS**

| | | | I. *Classification When Drilling Is Started* | II. *Classification after Completion or Abandonment* | |
|---|---|---|---|---|---|
| | | | | *Successful* | *Unsuccessful* |
| | | | *A* | *B* | *C* |
| Drilling for long extension of partly developed pool | | | 1 Outpost (Extension test) | 1 Extension well (Sometimes a new-pool discovery well) | 1 Dry outpost (Dry extension test) |
| Drilling for a *new pool* on a structure or in a geological environment already productive | New pool tests | Drilling within limits of proved area of pool — For new pool above deepest pool | 2a Shallower-pool test | 2a Shallower-pool discovery well (Sometimes shallower-pool extension well) | 2a Dry shallower-pool test |
| | | Drilling within limits of proved area of pool — For new pool below deepest pool | 2b Deeper-pool test | 2b Deeper-pool discovery well (Sometimes deeper-pool extension) | 2b Dry deeper-pool test |
| | | Drilling outside limits of proved area of pool | 2c New-pool wildcat | 2c New-pool discovery wildcat (Sometimes an extension well) | 2c Dry new-pool wildcat |
| Drilling for a *new field* (or a structure or in an environment never before productive) | | | 3 New-field wildcat | 3 New-field discovery wildcat | 3 Dry new-field wildcat |

(Or, in places, extension wells) — New-pool discovery wells

Dry new pool tests

**TABLE 2—NUMBER OF OIL WELLS, GAS WELLS, CONDENSATE WELLS, AND DRY HOLES DRILLED IN UNITED STATES AS EXPLORATORY TESTS IN 1953**

| | Oil producers | | Gas producers | | Condensate producers | | Total producers | | Dry holes | | Grand total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| State— | No. of holes | Footage | No. of holes | Footage | No. of holes | Footage | No. of holes | Footage | No. of holes | Footage | No. of holes | Footage | Average depth of hole* |
| Alabama | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 79 | 409,188 | 79 | 409,188 | 5,180 |
| Arizona | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 20,315 | 6 | 20,315 | |
| Arkansas | 18 | 100,681 | 1 | 586 | 0 | 0 | 19 | 101,267 | 101 | 405,480 | 120 | 506,747 | 4,223 |
| California | 79 | 421,679 | 19 | 76,075 | 0 | 0 | 98 | 497,754 | 517 | 2,319,394 | 615 | 2,817,148 | 4,581 |
| Colorado | 36 | 201,533 | 15 | 73,317 | 0 | 0 | 51 | 274,850 | 323 | 1,717,040 | 374 | 1,991,890 | 5,326 |
| Florida | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 34 | 213,585 | 34 | 213,585 | 6,282 |
| Georgia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 24,504 | 10 | 24,504 | |
| Idaho | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 17,070 | 5 | 17,070 | |
| Illinois | 67 | 182,274 | 2 | 686 | 0 | 0 | 69 | 182,960 | 502 | 1,087,357 | 571 | 1,270,317 | 2,225 |
| Indiana | 57 | 86,624 | 4 | 3,552 | 0 | 0 | 61 | 90,176 | 448 | 730,344 | 509 | 820,520 | 1,612 |
| Iowa | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 443 | 1 | 443 | |
| Kansas | 296 | 1,011,023 | 48 | 208,759 | 0 | 0 | 344 | 1,219,782 | 1,285 | 4,716,127 | 1,629 | 5,935,909 | 3,644 |
| Kentucky | 68 | 119,941 | 12 | 34,321 | 0 | 0 | 80 | 154,262 | 320 | 616,457 | 400 | 770,719 | 1,927 |
| Louisiana | 98 | 911,913 | 15 | 158,014 | 38 | 446,555 | 151 | 1,516,482 | 476 | 4,107,608 | 627 | 5,624,090 | 8,970 |
| Maryland | 0 | 0 | 1 | 7,238 | 0 | 0 | 1 | 7,238 | 0 | 0 | 1 | 7,238 | |
| Michigan | 20 | 52,729 | 6 | 14,816 | 0 | 0 | 26 | 67,545 | 257 | 638,396 | 283 | 705,941 | 2,494 |
| Mississippi | 13 | 87,862 | 2 | 8,862 | 4 | 32,925 | 19 | 129,649 | 176 | 1,240,280 | 195 | 1,369,929 | 7,025 |
| Missouri | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 4,050 | 2 | 4,050 | |
| Montana | 14 | 91,231 | 1 | 3,263 | 0 | 0 | 15 | 94,494 | 148 | 755,390 | 163 | 849,884 | 5,214 |
| Nebraska | 24 | 108,327 | 9 | 42,992 | 0 | 0 | 33 | 151,319 | 130 | 625,680 | 163 | 776,999 | 4,767 |
| Nevada | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 12,015 | 8 | 12,015 | |
| New Mexico | 34 | 273,426 | 18 | 79,136 | 4 | 26,990 | 56 | 379,552 | 139 | 814,198 | 195 | 1,193,750 | 6,122 |
| New York | 0 | 0 | 1 | 1,855 | 0 | 0 | 1 | 1,855 | 22 | 42,501 | 23 | 44,356 | |
| North Carolina | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 7,801 | 2 | 7,801 | |
| North Dakota | 28 | 211,020 | 0 | 0 | 0 | 0 | 28 | 211,020 | 78 | 394,887 | 106 | 605,907 | 5,716 |
| Ohio | 5 | 11,800 | 21 | 53,201 | 0 | 0 | 26 | 65,001 | 67 | 197,366 | 93 | 262,367 | 2,821 |
| Oklahoma | 177 | 811,183 | 44 | 202,068 | 7 | 36,742 | 228 | 1,049,993 | 736 | 3,045,422 | 964 | 4,095,415 | 4,248 |
| Oregon | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1,894 | 1 | 1,894 | |
| Pennsylvania | 0 | 0 | 24 | 178,766 | 0 | 0 | 24 | 178,766 | 33 | 207,984 | 57 | 386,750 | 6,785 |
| South Dakota | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 90,988 | 18 | 90,988 | |
| Tennessee | 8 | 8,080 | 1 | 595 | 0 | 0 | 9 | 8,675 | 21 | 25,551 | 30 | 34,226 | 1,141 |
| Texas | 883 | 4,416,440 | 176 | 981,286 | 130 | 1,008,697 | 1,189 | 6,406,423 | 4,404 | 21,422,923 | 5,593 | 27,829,346 | 4,976 |
| Utah | 8 | 57,257 | 8 | 39,771 | 0 | 0 | 16 | 97,028 | 43 | 239,220 | 59 | 336,248 | 5,699 |
| Virginia | 0 | 0 | 6 | 43,953 | 0 | 0 | 6 | 43,953 | 9 | 41,679 | 15 | 85,632 | |
| Washington | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 6,111 | 2 | 6,111 | |
| West Virginia | 2 | 3,351 | 77 | 211,173 | 0 | 0 | 79 | 214,524 | 21 | 50,999 | 100 | 265,523 | 2,655 |
| Wyoming | 46 | 263,326 | 5 | 14,684 | 0 | 0 | 51 | 278,010 | 209 | 1,029,546 | 260 | 1,307,556 | 5,029 |
| Total U. S. | 1,981 | 9,431,700 | 517 | 2,438,969 | 182 | 1,551,909 | 2,680 | 13,422,578 | 10,633 | 47,279,793 | 13,313 | 60,702,371 | 4,560 |
| Average depth per hole | | 4,761 | | 4,718 | | 8,527 | | 5,008 | | 4,447 | | 4,560 | |

*Average per well footage given only where 25 or more wells were drilled in a state.

on the other hand. Distinction among these three classes of operators is not always easy, and in some instances the same company may be regarded as a "major" in one district, but as a "minor" in another district.

In order to standardize use of these terms in connection with these exploratory statistics, the committee drew up definitions over 2 years ago, and in the present annual report it is adhering to them *(see The Oil and Gas Journal, April 7, 1952)*.

Our statistics showed that in the country as a whole in 1953, 1,153 new-field wildcats (196 producers and 957 dry holes) were drilled by majors; 4,856 new-field wildcats (497 producers and 4,359 dry holes) were drilled by minors and independents; and 916 new-field wildcats (81 producers and 835 dry holes) were drilled by minors or independents with at least 50 per cent of the cost of drilling contributed by major companies.

**Size of discoveries . . .** Some years ago we included in our annual report a table showing the number of fields discovered each year, from 1938 to the year preceding the year reported, these fields being grouped according to a rough estimate of their total ultimate reserves from the date of discovery. The fields were grouped according to these estimates: A, meaning a total ultimate of 50 million barrels or more; B, from 25 to 50 million barrels; C, from 10 to 25 million barrels; D, from 1 to 10 million barrels; E, less than 1 million barrels; and F, abandoned. Gas fields were not included unless they also produced oil or condensate. A few fields were omitted where satisfactory estimates were not readily obtainable.

In the present report, we are repeating our approach of the past 4 years. We are recording, in Table 5, estimated total ultimate reserves only for the discoveries of 1947, 1950, and 1953. This is the fifth year in which we have attempted such an estimate of the fields discovered in the year just closed. Previously we allowed a year to elapse. The estimates in Table 5 were all made in January 1954. Those referring to discoveries in 1947 and 1950 were revisions, where revisions seemed necessary.

In revising the earlier estimates for discoveries of 1947, as made in January 1951, one B was lowered to C; one C was raised to B; one C was lowered to D; three D's were raised to C; two E's were raised to C; seven E's were raised to D; four D's were lowered to E, and six F's, temporarily abandoned, were finally completed as E's. Nineteen E's were lowered to F. In revising the earlier estimates for 1950 (made in January 1951), 1 B was low-


**THE AUTHOR**

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**TABLE 3—BASIS FOR LOCATING NEW-FIELD WILDCATS DRILLED IN 1953**

| | Geology | | Geophysics | | Geology and geophysics | | Sundry nontechnical | | Unknown | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| State— | Producers | Dry holes | Producers | Dry holes | Producers | Dry holes | Producers | Dry holes | Producers | Dry holes | Producers | Dry holes | Grand total |
| Alabama | 0 | 51 | 0 | 7 | 0 | 6 | 0 | 0 | 0 | 12 | 0 | 76 | 76 |
| Arizona | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 6 | 6 |
| Arkansas | 9 | 83 | 0 | 2 | 2 | 10 | 0 | 0 | 0 | 0 | 11 | 95 | 106 |
| California | 11 | 154 | 3 | 13 | 4 | 61 | 0 | 52 | 0 | 21 | 18 | 301 | 319 |
| Colorado | 4 | 31 | 15 | 162 | 2 | 15 | 1 | 40 | 0 | 10 | 22 | 258 | 280 |
| Florida | 0 | 6 | 0 | 21 | 0 | 5 | 0 | 2 | 0 | 0 | 0 | 34 | 34 |
| Georgia | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | 10 | 10 |
| Idaho | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 5 | 5 |
| Illinois | 19 | 132 | 3 | 17 | 0 | 0 | 1 | 8 | 0 | 6 | 23 | 163 | 186 |
| Indiana | 20 | 327 | 1 | 2 | 0 | 0 | 0 | 0 | 2 | 21 | 23 | 350 | 373 |
| Iowa | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| Kansas | 9 | 112 | 8 | 47 | 1 | 6 | 0 | 0 | 9 | 110 | 27 | 275 | 302 |
| Kentucky | 7 | 93 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 15 | 8 | 110 | 118 |
| Louisiana | 13 | 132 | 21 | 100 | 20 | 89 | 0 | 0 | 0 | 2 | 54 | 323 | 377 |
| Maryland | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Michigan | 9 | 172 | 4 | 7 | 0 | 6 | 0 | 0 | 0 | 0 | 13 | 185 | 198 |
| Mississippi | 12 | 105 | 5 | 25 | 0 | 31 | 0 | 0 | 0 | 12 | 17 | 173 | 190 |
| Missouri | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 2 |
| Montana | 3 | 31 | 2 | 48 | 1 | 20 | 0 | 22 | 0 | 0 | 6 | 121 | 127 |
| Nebraska | 0 | 1 | 17 | 83 | 0 | 0 | 0 | 7 | 0 | 15 | 17 | 106 | 123 |
| Nevada | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 6 | 0 | 8 | 8 |
| New Mexico | 14 | 56 | 12 | 34 | 0 | 5 | 0 | 0 | 0 | 21 | 26 | 116 | 142 |
| New York | 0 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 4 | 1 | 18 | 19 |
| North Carolina | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 2 |
| North Dakota | 0 | 5 | 4 | 31 | 0 | 19 | 3 | 13 | 0 | 0 | 7 | 68 | 75 |
| Ohio | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 1 | 0 | 7 | 7 |
| Oklahoma | 15 | 145 | 16 | 117 | 1 | 1 | 0 | 0 | 0 | 0 | 32 | 263 | 295 |
| Oregon | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |
| Pennsylvania | 0 | 10 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 6 | 1 | 17 | 18 |
| South Dakota | 0 | 3 | 0 | 10 | 0 | 1 | 0 | 4 | 0 | 0 | 0 | 18 | 18 |
| Tennessee | 2 | 14 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 18 | 20 |
| Texas | 204 | 1,474 | 101 | 1313 | 66 | 440 | 14 | 222 | 50 | 392 | 435 | 12,841 | 3,276 |
| Utah | 2 | 23 | 2 | 6 | 0 | 6 | 0 | 2 | 0 | 0 | 4 | 37 | 41 |
| Virginia | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 5 | 5 |
| Washington | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 2 | 2 |
| West Virginia | 11 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 5 | 16 |
| Wyoming | 4 | 38 | 7 | 36 | 2 | 21 | 1 | 29 | 1 | 7 | 15 | 131 | 146 |
| Total | 368 | 3,227 | 221 | 1,086 | 100 | 745 | 21 | 426 | 64 | 667 | 774 | 6,151 | 6,925 |

[1]Includes three dry holes located by geochemistry. [2]Includes four dry holes located by geochemistry.

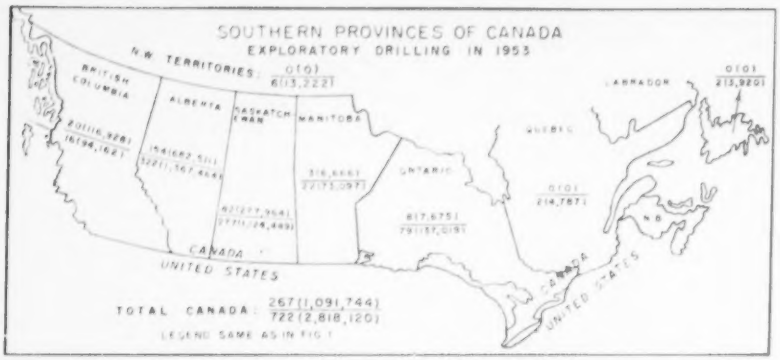


**Fig. 2—Canada drilled 989 wildcats as shown here.**

ered to D, 2 C's were raised to B; 5 C's were lowered to D; 1 D was raised to B; 10 D's were raised to C; 13 D's were lowered to E; 1 E was raised to B; 2 E's were raised to C; 27 E's were raised to D; and 47 E's lowered to F.

It is our plan to make these estimates of the fields discovered in any given year only 3 and 6 years, respectively, after their dates of discovery, with a rough preliminary estimate given just after their discovery. It is very doubtful whether the first estimates for the discoveries of the year just elapsed can be of much significance, for not enough is yet known of the various factors which should enter into an estimate of this kind.

In western Canada, in 1953, 898 exploratory holes were completed, 259 of these being producers and 639 being dry holes (Fig. 2). The producers included 141 oil wells and 118 gas wells. A total of 3,756,463 ft. was drilled, 1,084,069 in producers and 2,672,394 ft. in dry holes. This means that 28.8 per cent of the exploratory holes and 28.29 per cent of the exploratory footage were successful. There were 2.46 ft. drilled in dry holes for every foot drilled in producers. For every producer completed, 2.46 dry holes were abandoned. The average depth of all the exploratory holes was 4,183 ft.

Among the 615 new-field wildcats completed in western Canada in 1953, 96 were successful and 519 were dry. In other words, new-field wildcatting was 15.3 per cent successful. One producer was drilled for every 5.5 dry holes.

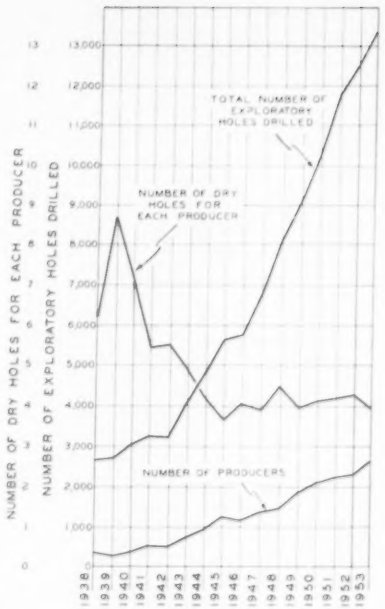


**Fig. 3—Relative success of exploratory drilling in United States from 1938 through 1953.**

In eastern Canada, 91 exploratory holes were drilled, with a total of 153,401 ft. Of the 91 holes, 8 were successful, 4 as gas wells, and 4 as oil wells, and all in southwestern Ontario. In these producers, 7,673 ft. was drilled. Of the 91 holes, 8.8 per cent were successful; 5.0 per cent of the exploratory footage was in successful holes. For every foot drilled in producers, 18.9 ft. was drilled in dry holes. Average depth of hole was 1,685.7 ft.

Data on exploratory drilling in 1953 in Mexico (provided by Pemex) are listed in Table 6. One hundred twenty-eight exploratory holes were drilled, with a total of 515,462 ft. Of these holes 59 (49 oil wells and 10 gas wells) were successful, these 59 holes having a total of 243,323 ft. According to these figures, this exploratory program was 46.1 per cent successful. For each producer-foot, 1.11 ft. was drilled in dry holes. Average depth of 128 holes was 4,027 ft.

Forty-seven of the 128 holes were new-field wildcats, and 13 of these, or 27.6 per cent, were successful. All were drilled on a technical basis as follows:

Two producers and four dry holes were located on geology.

Ten producers and 18 dry holes were located on geophysics.

Two producers and 11 dry holes were located on geology and geophysics.

**TABLE 4—RELATIVE SUCCESS OF EXPLORATORY DRILLING IN UNITED STATES FROM 1944 TO 1953, INCLUSIVE**

| | New-field wildcats | | All exploratory holes | |
|---|---|---|---|---|
| Year | No. of dry holes each producer | Percentage of wells successful | No. of dry holes each producer | Percentage of wells successful |
| 1944 | 8.05 | 11.05 | 4.08 | 19.67 |
| 1945 | 7.63 | 11.59 | 3.62 | 21.64 |
| 1946 | 8.39 | 10.65 | 4.06 | 19.76 |
| 1947 | 7.80 | 11.32 | 3.90 | 20.34 |
| 1948 | 7.57 | 11.66 | 4.50 | 18.25 |
| 1949 | 7.79 | 11.37 | 3.95 | 20.20 |
| 1950 | 7.93 | 11.19 | 4.11 | 19.54 |
| 1951 | 8.05 | 11.05 | 4.30 | 18.86 |
| 1952 | 8.05 | 11.06 | 4.32 | 18.78 |
| 1953 | 7.95 | 11.18 | 3.98 | 20.13 |
| 1944-1953, inclusive | 7.74 | 11.44 | 4.10 | 19.60 |

**TABLE 5—FIELDS* DISCOVERED IN 1947, 1950, AND 1953, GROUPED ACCORDING TO THEIR TOTAL ULTIMATE RESERVES AS ESTIMATED ON JANUARY 1, 1954**

| | Number of fields discovered in year indicated by reserves groups† | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | A | B | C | D | E | F | Total A—F inclusive | A + B + C fields | Percentage of A + B + C fields in total fields |
| 1947 | 4 | 7 | 15 | 52 | 165 | 58 | 301 | 26 | 8.64 |
| 1950 | 3 | 10 | 17 | 98 | 280 | 58 | 466 | 30 | 6.44 |
| 1953 | 0 | 4 | 13 | 74 | 505 | 7 | 586 | 17 | 2.90 |

*This table refers only to the states of Alabama, Arkansas, California, Colorado, Illinois, Indiana, Kansas, Kentucky, Louisiana, Michigan, Mississippi, Montana, Nebraska, New Mexico, Oklahoma, Texas, and Wyoming. It does not include gas fields unless natural-gas liquids are produced, and then the reserves figure relates only to these liquids. A few fields were omitted because of inadequate estimates, and a few producing areas, at first thought to be new fields, have become consolidated with other fields.

†In this table, A means 50 million barrels or more, B means between 25 and 50 million barrels, C means between 10 and 25 million barrels, D means between 1 and 10 million barrels, E means less than 1 million barrels, F means abandoned.

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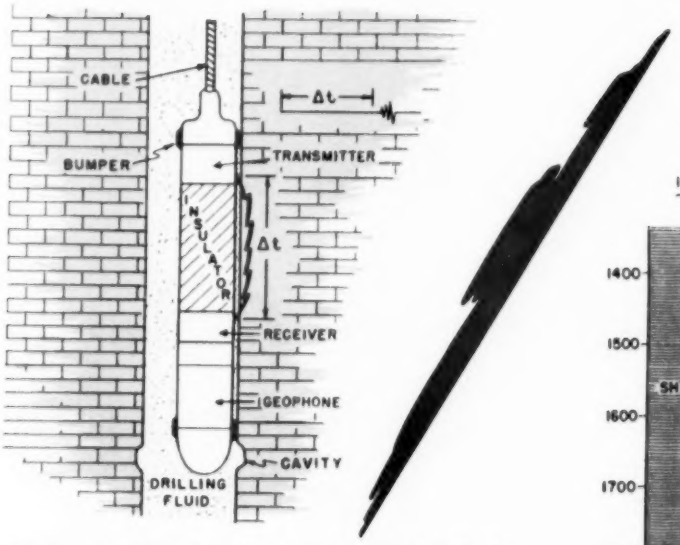


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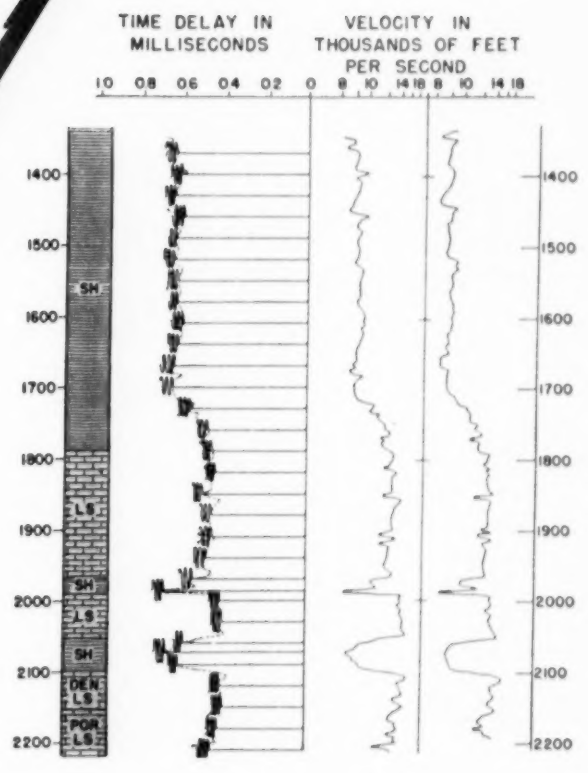


Diagrammatic illustration of the variation in time delay to form a composite velocity log and the comparison of two velocity logs from different wells in the same field.

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# STRAT OIL—*Rockies' Biggest Challenge*

## *Vision, imagination, and the drill will find it*

**by Max L. Krueger**

A NUMBER of years ago, in 1939 to be exact, a geologic comtemporary, who was then in charge of exploration for one of the major oil companies in the Rocky Mountains, stated his company's exploration experts had decided, after long deliberation and arduous studies, that the Rocky Mountain province did not **quite** qualify as an economic oil and gas-producing area. Because of the results of these studies, his company had decided to wash the mud of the Rockies from its boots and to take its money bags and exploration personnel elsewhere in the hope of finding more lucrative oil and gas provinces.

This authoritative decision was based on the results of detailed investigations and meditations of some of the profession's best-known geologic talent. The reasons for quitting the Rocky Mountains were as follows: (1) Most closed structures were only partially filled with oil or gas; (2) there was too much black oil in the province; (3) there was too small a percentage of organic sediments in the stratigraphic section to justify large hydrocarbon accumulations; (4) most producing zones were hard, tight, and impervious; (5) the market and outlet for oil was poor; (6) recoveries per acre were low; and so on ad infinitum. This sad story, discouraging at the time, is a far cry from the present situation in the Rocky Mountain region, and almost needless to say that company is back in the thick of the exploration battle, and has since successfully established itself as one of the largest-producing Rocky Mountain companies. This story is told simply to illustrate how the tide can turn. There are many other similar stories.

The dictionary defines "frontier" as, "an uncertain or undeveloped region." With this definition in mind, this paper is an attempt to:

1. Outline some of our more important Rocky Mountain exploration frontiers.

2. Point out some of the prejudices which have kept exploration from crossing some of these frontiers.

3. Suggest a type of attack which will eventually lead to the conquering of at least some of them.

### Exploration Challenges

The more important of these exploration frontiers have been placed in a number of categories, in the approximate order of their importance. It seems best to disregard anticlinal exploration as it is not considered a frontier. It will always remain, however, as the foundation of our exploratory thinking.

**Paleozoic pinchouts . . .** The No. 1 category is that of "Paleozoic pinchouts or buttresses against old positive elements." A few of these follow:

In South Central Wyoming there is a prominent buttress or pinchout of Paleozoic rocks against the north end of the Sierra Madre Mountains. A more complete section 50 miles north supports some of our most prolific oil fields. Westward, and buried beneath the central part of the Green River basin, is the north-south trending Church Buttes-La Barge element or line

of folding which is here interpreted as a buried positive element inasmuch as there is seismic evidence of thinning of the sedimentary section against it.

In Colorado, the Las Animas arch and the north plunge of the Uncompahgre highland beneath the thick sediments of the Uinta basin are geologic anomalies to pique one's exploratory imagination. In addition, the early Pennsylvanian rests on basement in northeastern Colorado, showing that somewhere to the east and south, oil-producing rocks of the Central Kansas uplift either pinch out, are truncated, or buttress against this area.

In Utah and Colorado the west flank of the Uncompahgre highland remains as a geologic enigma, and it is well known that the San Rafael swell and Circle Cliff elements support a minimized Paleozoic section. The crests of these last two upwarps have been drilled dry, and it is an established fact that petroliferous rocks exist on their flanks.

In Arizona, the Defiance uplift is still a challenge to the geologic profession in that oil and gas fields which produce from Paleozoic rocks are known to the north and east of it, and the same Paleozoic rocks are absent in outcrop in the core of this old positive element.

**Overthrust folds . . .** No. 2 in the classification of Rocky Mountain exploration frontiers is captioned, "Anticlinal folds and stratigraphic traps in front of, or below, low-angle overthrusts."

One of the best examples of this type of exploration frontier is the disturbed belt area of Alberta and North Central Montana. This same structural belt produces from both above and below the Lewis overthrust in Alberta, while similar geologic conditions in Montana have not yielded, as yet, to exploration overtures. The northeast flank of the Beartooth Mountains in Montana portrays a similar geologic situation on a smaller scale.

In Wyoming, the east door of the Wyoming Range, the southwest side and certainly the south end of the Wind River Range, the north flank of the Uintas, the south side of the Owl Creek Mountains, the south flank of the Sweetwater arch, the south side of the Ferris-Freezeout line of folding, and the east front of the Medicine Bow Mountains all qualify as deserving frontiers for this type of exploration.

**Lacustrine sediments . . .** The third category of exploration frontiers can be dubbed, "Stratigraphic traps in Lacustrine sediments around the peripheries of Tertiary intermontane basins." These frontiers are almost totally unexplored. The Vernal asphalt ridge in the Uinta basin is undoubtedly an excellent example of a "scalped" or fossil stratigraphic oil field. The gas in Paleocene offshore sand bars at Big Piney and Tip Top Shallow, on the west side of the Green River basin, also come under this classification. In addition, a number of oil and gas fields south and southeast of the Rock Springs uplift produce both oil and gas from Eocene and Paleocene rocks under stratigraphic-trap conditions even though the predominating structural control is domal or anticlinal. With the exception of a few examples, this category is unexplored.

**Reefs . . .** A fourth classification for this review of exploration frontiers is that of "reef development areas."

Certain portions of the Williston basin, the south rim of the Paradox basin, and the southern portion of the San Juan basin apparently sponsored environmental conditions, during certain stages in Paleozoic time, which were conducive to the development of limestone reefs which so often contain the porosity necessary to support an accumulation of oil and gas. Most studies concerning the location of these "reef fairways" are in the speculative-geology stage at the present time. The eastern flank of the Las Animas arch and the east and west flanks of the San Rafael swell are other localities where reef developments should be present, in Paleozoic rocks.

**Stratigraphic wedges . . .** "Wedge-edge sand traps" is the fifth Rocky Mountain exploration frontier. The tilted "offshore bars" of Weston and Niobrara counties, Wyoming, have certainly been a piquant reminder of a somewhat unorthodox Rocky Mountain oil and gas accumulation. The pattern of these important accumulations was sketched out years ago by the shallow production at Osage, and it has taken a long time to enlarge upon this pattern and to find similar producing areas first at Mush Creek, then at Fiddler Creek, Clareton, Black Thunder, and now southward into Niobrara County.

"We are all too prone to build geologic barriers around certain geologic provinces, insofar as their ability to produce oil and gas is concerned."


THE AUTHOR

**Max L. Krueger is a geological consultant in Laramie, Wyo. This paper was presented as the keynote address at the fourth annual meeting of the Rocky Mountain Section of the A.A.P.G. in Albuquerque, N. M., on February 23.**


Pinchouts in Cretaceous sands on many of the major anticlinal features in the Rocky Mountains have and are receiving more and more attention, and it is only reasonable to assume that stratigraphic plays, based on regional studies and speculative geology, will become more and more prevalent. Stratigraphic oil production in the Rocky Mountains is becoming a more and more important factor. At the present time, stratigraphic production may constitute as much as 15 per cent of the current rate.

**Salt domes . . .** Another frontier which is still untamed but which continues as a challenge, is the attempt to find commercial quantities of gas and oil associated with salt horsts or salt domes. Efforts in this direction have largely been limited to the Paradox basin. The association of oil and gas with evaporite deposits in the Paradox basin has long been known, but the finding of appreciable sustained production is **one** of the hurdles which the profession has yet to clear.

### Conquered Frontiers

Following this review of the many exploration frontiers which challenge geologists in the Rocky Mountains, it is perhaps apropos to reminisce about some of the **old** Rocky Mountain exploration frontiers which have succumbed to exploration efforts during the past few years. Rocky Mountain geologists, of course, look to these with some pride and as a job well done.

1. The Julesburg basin has finally come into its own, after years of unyielding exploration.

2. The Williston basin, that previous wide expanse of enigmatic geology, has finally been tapped, both as to structural and stratigraphic accumulations of oil and gas.

3. The Wasatch plateau of Utah has yielded one of the largest natural-gas reserves. Surely this was entirely unpredictable—some don't believe it yet.

4. Weston County, Wyoming, has shown that nature often repeats herself, and any number of tilted sand-bar traps have been discovered, similar to Osage.

5. The well-known Nesson anticline

in western North Dakota, which may actually have been discovered years ago, has finally proved that it is the "elephant" which it should be.

6. Deep production from Paleozoic rocks on the Baker-Glendive anticline has finally been proved after a number of disastrous attempts.

7. Rangely, after having been actually discovered in the Tensleep, and lying dormant for years, finally came into its own as the Rocky Mountain's largest producing field.

### Unconquered Frontiers

These, however, are the frontiers which we have **not** been able to cross and to tame:

**Cambridge arch . . .** The Cambridge arch in Central Nebraska is still a puzzle as to the type of exploration which will make it yield the oil and gas which **should** be trapped along its general axis.

**Las Animas arch . . .** The Las Animas arch has held geologists off its frontiers for 50 years or more. The Powder River, Red Desert, Wind River, and Green River basins have refused to yield to exploration insofar as their central parts are concerned, regardless of the fact that progress has been shown around their peripheries.

**Others . . .** The Paradox and Black Mesa basins still remain a challenge to the best geologic and exploration efforts.

There are many others.

### Geological Prejudices

In summary, although there have been some well-earned successes there have also been some dismal failures in the plan of campaign to cross some of our exploration frontiers. Economics and geography have been hampering influences. Rugged terrain, bad weather conditions, poor pipe-line outlets, and fluctuating markets have had their part in making some of these frontiers difficult to cross. These can be alibied with smug satisfaction. But the one thing which geologists **cannot** alibi with any degree of respect for their profession, is their inability to do away with the many geologic prejudices which are set up as standards by which to evaluate certain geologic provinces and their ability to yield commercial oil or gas.

The dictionary says that a prejudice is "an opinion formed without taking time and care to judge fairly." Another, and preferable definition, as it applies more exactly to geologic prejudice or prejudices is, "premature judgment based on insufficient evidence, or, apparent facts which are later proved untenable by subsequent developments." We are all too prone to build geologic barriers around certain geologic provinces, insofar as their ability to produce oil and gas is concerned. These prejudices are often based simply on introductory and nonconclusive results obtained from the first feeble exploration efforts in a new area. Here are some of these **old** prejudices in the Rocky Mountains:

1. The Tensleep was thought for many years to be too hard, tight, and impervious to produce appreciable commercial quantities of oil. It was thought also to contain only heavy, black, sulfurous oil.

2. Many geologists believed that there would be no commercial oil or gas found in northeastern Colorado—apparently, at least, all of the most important structural features had been drilled and tested and although some of the Lower Cretaceous sands contained oil saturation, they were all to hard, tight, and impervious to yield oil in paying quantities.

3. San Juan basin gas wells were considered as noneconomic, and in addition the known accumulations were thought to be unimportant because the accumulation was **not** structural.

4. The Dakota sandstone was thought to be too hard and tight in many areas to have a good payout. Its porosity, and the porosity of **all** Lower Cretaceous sands for that matter, was supposed to be inhibited and its permeability ruined by a bentonitic matrix which expanded when in contact with drilling fluids, thus ruining the original reservoir characteristics of the sands. This has been only partially true. In contradiction, at Church Buttes where this clogging effect was first highly publicized, it has since been proved that within the space of one location, the reservoir characteristics can change so quickly that friable, loose sands tend to cut out the surface fittings in some of the wells, while other structurally favorable wells cannot be completed commercially.

5. Oil supposedly never could be produced from the Green River oil shales of the Uinta-Piceance basin because Green River **shale** oil is not actually liquid oil. Some of the early investigators even explained the tar sands of Asphalt ridge as being the erosional residue from Weber oil sands which outcropped against the Uintas and were eroded in Tertiary time and redeposited in the Asphalt ridge area. Others were equally sure that all of the residual oil around the periphery of the Uinta basin, and in Tertiary rocks, was of Cretaceous origin.

6. Oil and gas could **not** exist in liquid form at depths in excess of 10,000 ft.

7. Oil and gas could **not** be associated with nonmarine beds because marine or organic sediments are necessary for the generation of petroleum and natural gas.

8. Certain sands were supposedly "too thick" to carry oil or gas saturation.

9. All sands below 10,000 ft. were supposed to be quartzitic and too impervious to carry oil or gas.

10. The Cambrian could **not** produce oil. It never had, so it naturally could not, in the Rocky Mountains at least.

There were many other geologic barriers and fences which were built in the old days simply on the basis of personal or hearsay opinions or prejudices. Luckily, there were many geologists and exploration specialists who did not know about these prejudices, through a lack of knowledge of the country, or who refused to recognize them, and for this reason we have been successful in relegating many of these prejudices to the junk pile and in hurdling many of the geologic fences.

There are still a number of important exploration fences and prejudices to hurdle, but our ability to eventually solve these problems, even if slowly, has been established.

For instance, the ability to detect oil and gas sands while drilling through them is at best only in its primary development. Mud and sample logging is a far cry from an exact science. Electric-log interpretation is subject to many misinterpretations, and core analyses can be badly misleading. Formation testing, although greatly improved, is still a clumsy and costly operation and subject to many failures. Economic slim-hole exploration, although some 15 to 20 years old as a project, is far from being successful, both from an exploration and a cost standpoint.

### Gas Frontiers

Mention should be made here of the fact that exploration for commercial accumulations of **natural gas** is ever increasing in importance to the geologic profession. A few short years ago gas was a menace to oil exploration. Many are the instances in the early days of the oil industry where gas was allowed to blow wild because there was no demand, outlet, or market for it, and because it hindered deeper drilling in search for oil. Within a short span of 10 years or less, the economics of the gas business have changed so rapidly that one can hardly keep abreast of the situation. Ten years ago gas in the Rocky Mountains was either of no value, provided there was no pipeline connection, or it was contracted

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at from 2 to 4 cents per thousand at well head. With the building of large pipelines to the industrial and population centers in the East, gas has rapidly increased in value until reports of contracts of 22 to 24 cents at well head have recently been circulated. Published contracts, ranging from 15 to 19 cents, are certainly authentic.

As additional pipelines are built, it becomes a challenge to cross and tame these prospective gas frontiers and there is every reason to believe that it won't be long until all Rocky Mountain geologists will be charged with the finding of additional gas reserves for gas-hungry pipelines which will soon service all corners of the United States.

### Questions for the Future

Now, there are some challenging questions to ask. Geologists are all going to be confronted with these questions sooner or later:

1. Who is going to be the first to extend the Embar trend or fairway southward into northwestern Colorado and eastern Utah?

2. Who will eventually test the Tensleep or even the Madison on the Church Buttes-La Barge element in the Green River basin?

3. Who will find oil or gas on the flanks or plunges of such large positive elements the the Uncompahgre highland, the San Rafael swell, Circle Cliffs, and the Sierra Madres?

4. Who will determine whether the block faulting, so characteristic of the Wasatch plateau, is due to subterranean Jurassic salt flowage?

5. Who will first find important oil or gas accumulations on small buried geophysical anomalies in the centers of such intermontane basins as the Powder River, Great Divide, Green River, and Wind River? The Julesburg and Uinta basins have finally yielded to exploration. Why not these other basins?

6. Who will first make the Las Animas arch produce?

7. Who will solve the mystery of finding commercial oil or gas associated with the salt horsts in the Paradox basin?

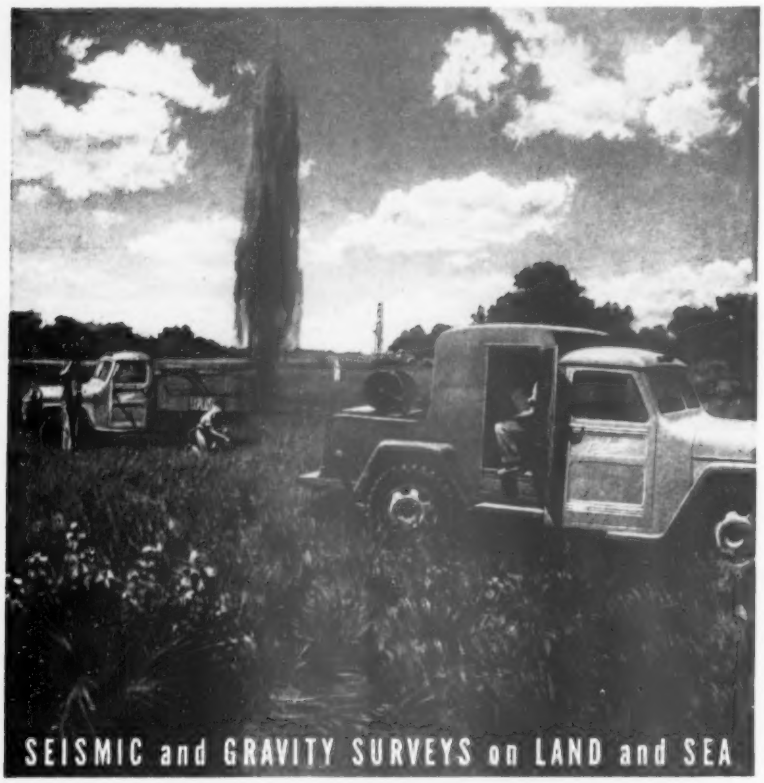
8. Who will first find oil in the area where the marine Jurassic, Triassic, and Permian rocks interfinger with their nonmarine equivalents along the eastern limb of the Cordilleran geosyncline?

To repeat—these are some of the untamed Rocky Mountain exploration frontiers.

### Summary

There's always something new in the exploratory geologic business. Geologists are challenged daily with the assignment of reevaluating their thinking in the light of new geologic information and discoveries which affect the oil provinces under study.

It is true that some new tools are needed in our profession for further oil finding. Geologists haven't had a really revolutionary tool since geophysical exploration stormed the profession a few years back. One of these new tools should be the application of speculative geology to some areas, admixing vision and imagination. This type of geologic thinking is necessary if we are to succeed in finding the stratigraphically trapped oil and gas which undoubtedly exist under many conditions throughout the Rocky Mountain region. This stratigraphic frontier has been barely tapped and it is now obvious that a large percentage of future oil and gas reserves in the Rocky Mountains must come from this source. Stratigraphic oil and gas accumulations are much more difficult to find than applying the time-honored policy of drilling only closed anticlines. This in turn simply means that we must drill more and still more wildcats. After all, the drill is still the most important exploratory tool, regardless of how well worn and rusty it may appear at times.

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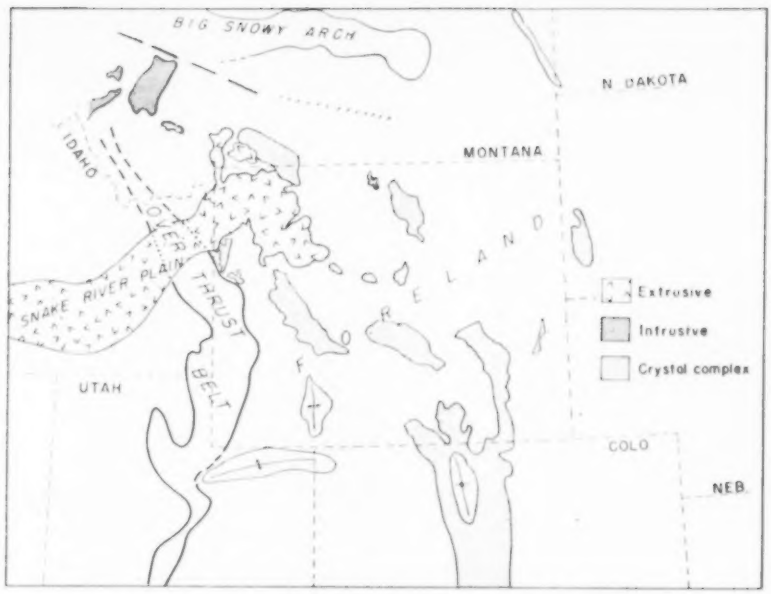


STRUCTURAL PROVINCES in Wyoming and neighboring states. Fig. 1.

# Wyoming Presents Problems in Structural Detail and History

**Needed . . .**

- Further study of pre-Cambrian.
- Techniques to determine relative age of folds.
- Evaluation of amount of similar folding present in anticlinal structures.
- Determination of mathematical curve which best expresses anticlinal folds.
- Quantitative study of fractures.
- Study of late Tertiary history.

**by D. L. Blackstone, Jr.**

WYOMING occupies parts of the southern Rocky Mountain, Great Plains, Wyoming basin, and middle Rocky Mountain physiographic provinces, with about equal areas in the latter three (Fig. 1). The structural features of the state lie in **two** tectonic provinces. The first is called the trough province because the present mountain ranges were formed from geosynclinal sediments of the Cordilleran trough and collectively constitute the "overthrust belt" of western Wyoming. The overthrust belt is a part of the arcuate area of complex structure which exists in Montana, Idaho, and Utah.

The remainder of Wyoming is located in the second province situated upon the shelf which formed the eastern margin of the Cordilleran trough. The simplicity of this twofold division is obscured in late Cretaceous and Cenozoic time.

### The Overthrust Belt

The overthrust belt (Fig. 2) is characterized by large thrust sheets bounded by westward-dipping, low-angle faults on some of which the lateral displacement is in excess of 35 miles. Wyoming contains the surface trace of the Darby and the Absaroka thrust faults, the latter considered to have the greatest displacement of any fault in the overthrust belt. Also present is the eastward-dipping Salt River thrust of doubtful origin and age.

The eastern limit of the Darby thrust sheet is concealed by overlapping Paleocene and Eocene rocks. Subsurface information concerning the thrust sheets is based on a limited amount of drilling such as that at Spring Creek, Afton, Leroy, Barrel Springs, Little Round Mountain, Tip Top, Lake Ridge and Snider basin. Data from wells suggest that the eastern thrusts are of low angle, but do not approach the near horizontality of the Bannock thrust sheet to the west.

**Fault plane attitude . . .** The problem of fault-plane attitude is important because in part the dip controls the distance that facies have been shifted laterally; **from what depths** of burial rocks have been elevated; and the possible nature of hydrostatic circulation. If the thrust faults have the characteristics of the very flat Bannock thrust, the lateral displacement of geosynclinal facies eastward toward the foreland is of tremendous magnitude. Numerous geologists have suggested that sediments deposited along a hinge line separating geosynclinal from foreland areas are likely to contain hydrocarbons. Sediments of strictly geosynclinal facies have **not** been rich prospecting ground. The breadth of the overthrust sheets and the dip of the fault planes are facts needed to solve the problem of where the hinge line exists at any given interval of geologic time.

The attitude of these fault planes may have had an initial dip approximately that of the strata in the trough prior to the deformation. The fact that no pre-Cambrian rocks appear in the overthrust sheets in western Wyoming—though Cambrian strata are involved—suggests that the slope of the sub-Cambrian floor exerted an ultimate effect upon the dip of the fault planes. Some evidence in regard to the slope of the sub-Cambrian floor has been given by Rubey, who states that "most major stratigraphic units double thickness every 10-15 miles westward." On the basis of an assumed thickness on the shelf a dip of about 8° for the sub-Cambrian surface is possible.

### The Foreland Area

All of Wyoming except the overthrust belt lies in that part of the continent comprising the stable shield or craton toward which the geosynclinal

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sediments were moved. This region may be called a foreland. The marine sedimentary section is thinner here than in the trough. Exceptions are intermontane deposits which locally attain great thickness. The geologic structures of the foreland reflect the response of the basement complex, rather than behavior of sediments alone.

**Folding and faulting . . .** The pre-Cambrian crystalline basement is exposed in the major structural features of the Wyoming foreland area. The exposures include:

Beartooth Mountains, Teton Range, Gros Ventre Mountains, Wind River Range, Owl Creek Mountains, Bighorn Mountains, Sweetwater arch, Rawlins uplift, Laramie Range, Medicine Bow Mountains, Sierra Madre Mountains, Hartville uplift.

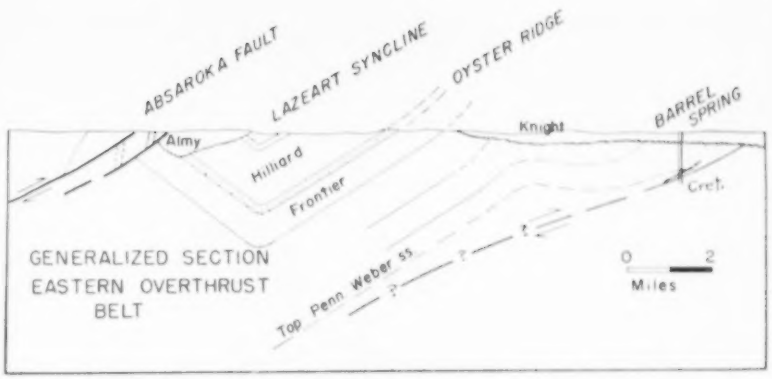
Love has presented an excellent summary of periods of folding and faulting in late Cretaceous and Tertiary time. He places the sites of earliest positive movement in the locale of the present Uinta, Bighorn, Medicine Bow, and Sierra Madre ranges.

An understanding of the time of deformation is important in the solution of problems relating to petroleum exploration. The position of **major** early uplifts and **subsequent** structural features is a reflection of controls which localized the applied stresses at any one time or place. Studies which will yield clues to localization of structural failure, may also yield clues as to the **time** of deformation. This frontier lies in the pre-Cambrian rocks but should be pursued nonetheless.

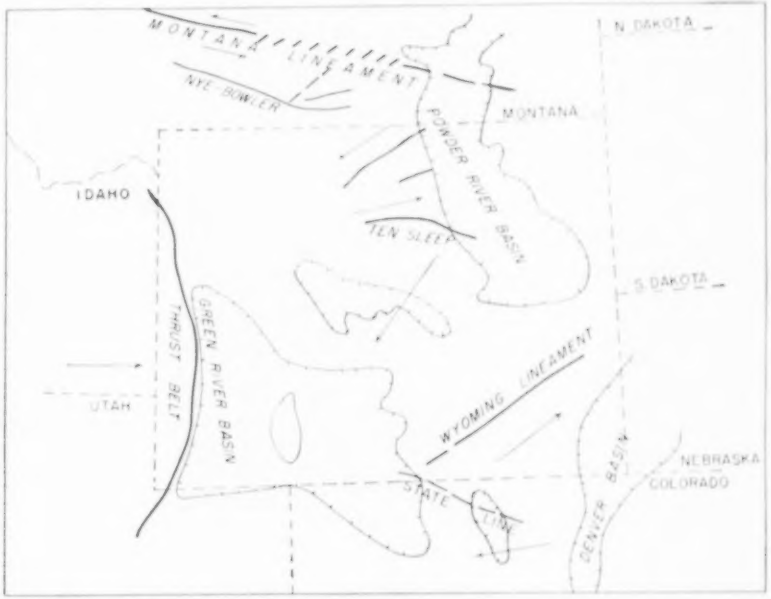
The distribution of bodies of homogeneous and massive granite in enclosing foliated rocks may explain the position of some mountain ranges in Wyoming. The parallelism of pre-Laramide with Laramide structure strongly suggests that the older controls the younger in the Beartooth Mountains, a part of the Wind River range, and part of the Bighorn Mountains. The Rawlins uplift, Sierra Madre Mountains, and the Medicine Bow Range, however, contain pre-Cambrian structural trends which are strongly divergent to present trends.

The results of early Laramide deformation were broad arches, which later became asymmetric and overthrust. These uplifts and intermontane basins restricted and localized the circulation of connate waters and set up pressure relations in which migrating hydrocarbons had to exist and reach equilibrium.

Deformation is a continuing affair, and as the major elements were further deformed, secondary folds and faults developed. The exact time that each of the secondary structural features came into existence will remain problematical. Certainly those that originated early were in a fortuitous position to entrap migrating hydrocarbons.




**WEST-EAST CROSS-SECTION through the eastern overthrust belt. Fig. 2.**




**STRUCTURAL LINEAMENTS of foreland province of Wyoming and adjacent areas. Fig. 3.**

## Lineaments

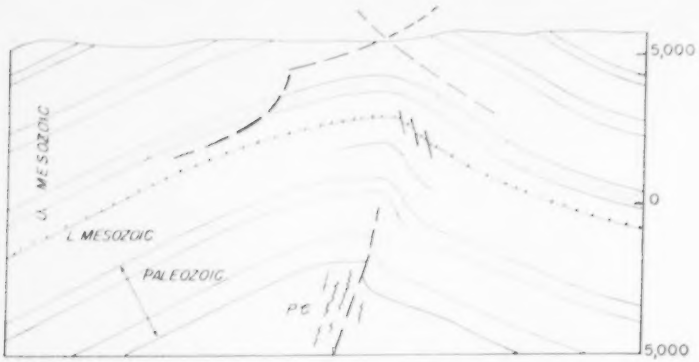
Structural lineaments are a major feature of the foreland province of Wyoming and adjacent areas and divide the area into a number of strips (Fig. 3).

**Montana . . .** The Montana lineament extends from the Coeur D'Alene district to the Lake Basin-Huntley fault zone and separates the overthrust, folded sedimentary ranges of Montana from the pre-Cambrian-cored individual uplifts of Wyoming. The lineament was active in late Cretaceous time and possibly influenced deposition as early as Permian time. The Nye-Bowler lineament—a similar feature—extends from Livingston, Mont., to the central Pryor Mountains.

**Wyoming . . .** In Wyoming, lineaments oriented variously across the prevalent northwest trend of the folds are: Northern Bighorn, Tensleep-Horn fault zone, Wyoming lineament, and State Line fault zone. These divide part of the state into strips.


### THE AUTHOR

**Dr. D. L. Blackstone, Jr., is professor of geology at University of Wyoming. Formerly geologist with Carter Oil Co., he was appointed to the staff of the university in 1946. He is a graduate of University of Washington (B.S., 1931), Montana State University (M.A., 1934), and Princeton University (Ph.D., 1936).**




**DIAGRAMMATIC CROSS-SECTION demonstrating features of Wyoming folds. Fig. 4.**

In any given strip the attitude of the axial surfaces of folds and the dip of fault planes is similar. Most of the folds in the central Bighorn strip are asymmetric to the east, whereas those in the broad strip between the Tensleep-Horn fault and the Wyoming lineament are asymmetrical to the southwest. The lineaments may vary in age from north to south with the State Line fault zone the youngest. A steep syncline in the early Pliocene North Park formation trends N 65° W across North Park and supports the conclusion.

No satisfactory explanation for the localization of the lineaments is at hand. Elsewhere in the world strike-slip movement measurable in miles is characteristic of such faults. Such movement is present on the Montana lineament and is possible for the Wyoming lineament. Problems concerning the lineaments are: (1) age relationships from north to south, (2) amount of strike-slip motion, and (3) reason for their position.

### Secondary Features

Several possible causes for the localization of the folds and faults within a strip have been listed. Several examples, ranging from the northern to the southern part of the area will be discussed.

**Local crowding . . .** Strike slip movement on the Montana lineament has locally crowded the sediments against the northwest corner of the Beartooth Mountain buttress, and developed folds and overthrust.

**Epianticlinal faults . . .** Major anticlines may develop local closures or "half-domes" along the trend due to crossfaulting. The localization of these features seems to be a part of the mechanism of development of the fold. Faults appear to develop parallel to the bedding and increase in dip upward. Such faults are usually well developed in the Cretaceous sands but do not extend downward into the Paleozoic rocks, nor upward into the Paleocene strata.

**Diagrammatic anticline . . .** A diagrammatic cross-section has been prepared (Fig. 4) to demonstrate features of some folds in Wyoming. A controlling fault may be developed due to foliated rocks in the basement complex, and extend upward into the incompetent Lower Paleozoic sequences. The competent carbonate sequence of the Lower Paleozic may be folded without visible or with only minor faulting. Fractures may exist, or may have been healed by deposition from circulating ground waters. Overlying Mesozoic sequences, particularly the Triassic and Jurassic rocks, may show similar folding or faults and thus he thinned on the steep limb of the fold. Faults which displace the Cretaceous sandstones appear related to adjustments between the strata, and originate as bedding-plane thrusts which increase in angle of dip toward the axis of the fold. Strata higher in the succession (Paleocene, etc.), may be folded without faulting. The result is a fold with three structural layers. Erosion has bared enough folds to sufficient depth to fairly well establish this pattern. Seismic investigation of such structures should not be considered complete with an interpretation based on only one structural layer.

**Sweetwater arch . . .** At the east end of the Sweetwater arch the pre-Cambrian complex and overlying sediments are well exposed. The pattern formed by folds and related faults, and faults alone, suggests a conjugate set of fractures such as would be expected across the plunging fold. The pattern of deformation here is believed to be due to stresses during Laramide orogeny rather than inherited features. The problem of deciding the age of fault systems seems best approached by regional relationships.

**Laramie range . . .** In the northern Laramie Range, fractures of possible pre-Cambrian age have influenced later deformation. Drainage patterns taken from aerial photographs show three predominant trends. One fault with strike-slip movement of about 1½ miles coincides with one of the fracture systems outlined by the drainage. It is suggested that the Laramide faulting followed an older and possibly pre-Cambrian fracture system.

**Other features . . .** In the Hanna-Carbon-Arlington area of southeastern Wyoming local subsidence of considerable magnitude took place in Paleocene and Eocene time. Along the southwest margin of the Hanna basin, upper rock units have been crowded out toward the basin margin to develop folds and thrust faults in which the basement complex apparently has not taken part. Cedar Ridge, St. Marys, Pass Creek Ridge, Simpson Ridge, and possibly Quealy have had such an origin.

This type of structure is anticipated in trough sites of deposition but may occur within restricted portions of the foreland.

**Normal faults . . .** In the past 10 years geologists throughout Wyoming have taken cognizance of extensive normal faulting of late Tertiary age. The faulting is in part post-Miocene, and in part post-late Pliocene in age. Details of Pliocene stratigraphy are fragmentary and as yet not fully understood. W. C. Knight recognized late Tertiary normal faulting in connection with the Sweetwater arch in 1900. Subsequently, Bauer and others added detailed information. Recently, post-Barstovian faulting has been recognized in and around the Sierra Madre Mountains.

This late Tertiary structural history poses many problems. In the Rawlins uplift, Barlow has demonstrated that many faults which originally had high-angle thrust characteristics have undergone a second period of movement. In the second period the original fault plane was the locus for normal faulting of considerable importance. Reversal of direction of movement on the same fault plane appears to be rather common in central Wyoming.

Problems associated with this widespread period of normal faulting are compounded by the low angle thrust faulting reported by Love in Jackson Hole. The extent of such thrusting in Wyoming is as yet not known. The normal and reverse fault sequence is closely spaced in time and suggests a

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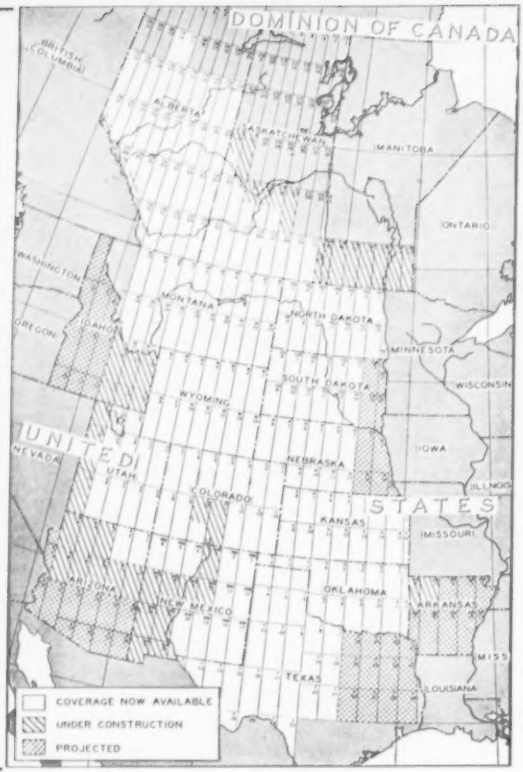




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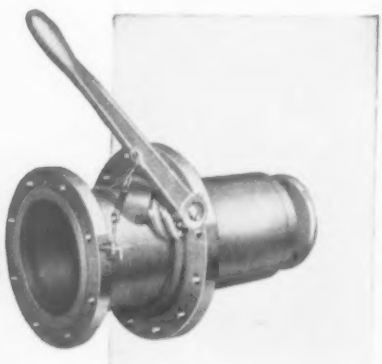

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rapid change in crustal conditions on a regional basis. The localization of the late Tertiary normal faulting in a zone trending N 65° W across Wyoming must have significance, as yet not understood. The diagram clearly indicates that the northern half of Wyoming was a very stable area during all of Tertiary time, while the central zone had continued adjustment.

Normal fault patterns, particularly adjacent to the oversteepened flanks of mountain ranges, may be due to a different cause. The fault pattern established by Franshawe for the Oil Creek Range has been recently corroborated by Tourtelet in the Bad Water area. The overriding mountain mass found insufficient support in the Paleocene-Eocene sediments of the footwall. Gravity acting on the fault mass has caused adjustment in the material beneath with consequent settling and normal faulting. Such type of feature may exist on the southwest flank of the Wind River Range.

### Conclusions

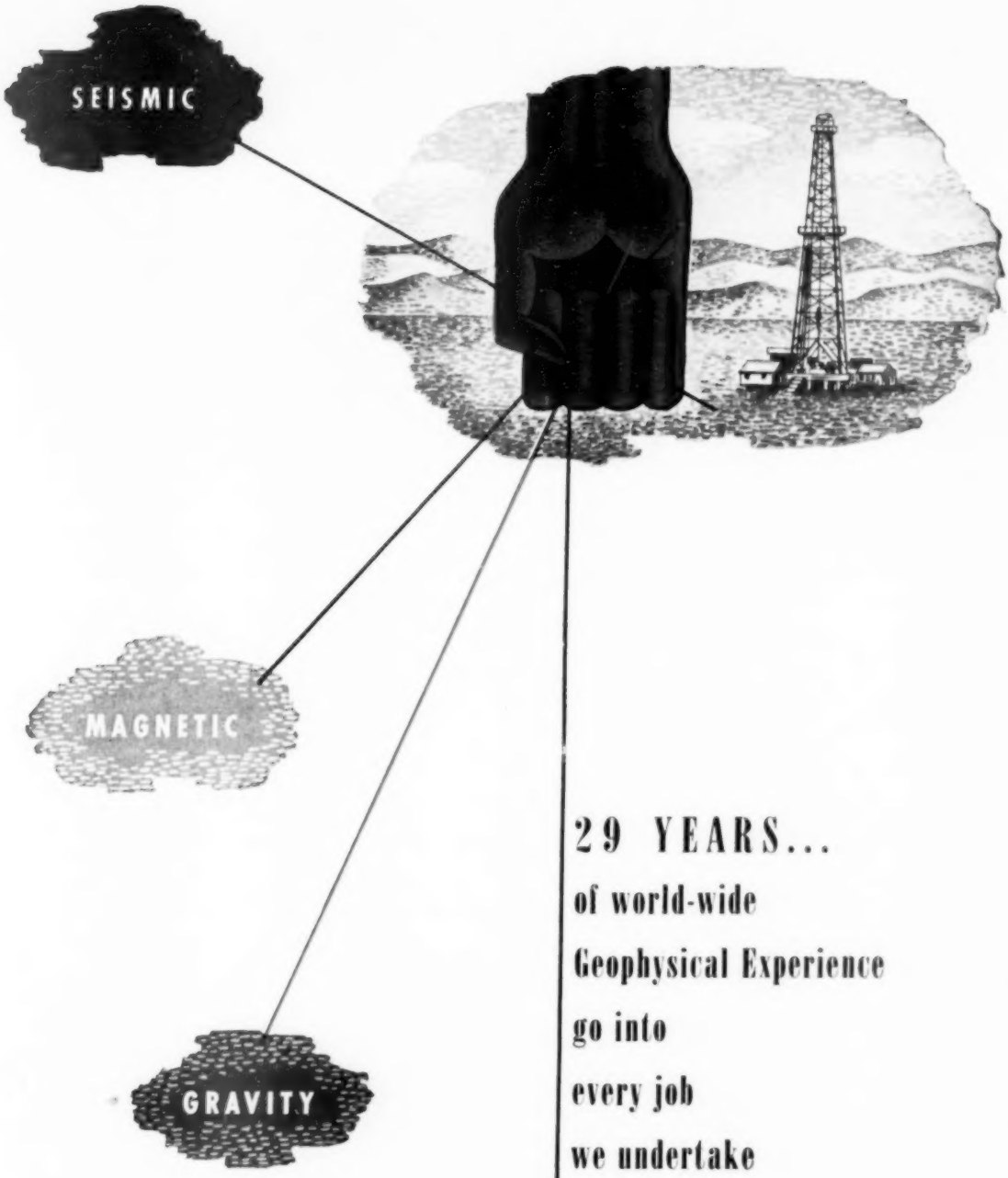
The writer would suggest that several problems in structural detail and history remain to be investigated in Wyoming. Briefly these include:

1. Further study of the pre-Cambrian for possible basement control.
2. Development of techniques to determine the relative age of folds.
3. Detailed study leading to the evaluation of the amount of similar folding present in Wyoming anticlinal structures.
4. Studies leading to an attempt to determine what mathematical curve best expresses anticlinal folds.
5. Quantitative study of fractures to determine the amount of void space that may be expected in certain types of folds.
6. More complete attention to late Tertiary history, particularly fault systems.

Many problems other than structural geology exist. Stratigraphy is considered to be the key to structural geology. The writer is of the opinion that much stratigraphic work neglects the structural aspect of the problems of petroleum exploration. Only by attention to both phases in balance can the best answers be obtained.

## Underground Storage

About 10 years ago there were only about 50 underground pools for storing natural gas in operation in the United States. At the end of 1952 there were 151 underground storage pools operating, with an estimated capacity of 1,290 billion cubic feet. During 1953 an additional 17 pools were under construction which would add another 282 million cubic feet to the capacity of these underground savings banks of the natural gas industry.

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# Gas Is Principal Target of Drill Bit

## *Utah-Colorado area considered favorable for large reserves*

**by Warren L. Taylor**

ALTHOUGH drilling in northeastern Utah and northwestern Colorado has been primarily concerned with the search for oil during the past several years, interest is now being centered on the area as a future gas supply. Today, with natural gas as a primary source of energy—supplying 22½ per cent of the nation's power—together with recent gas discoveries in the area under consideration, and the prospect of an outlet for the gas in this area, wells are being drilled here for the sake of finding gas.

This area can be described according to its major structural features as follows:

The area is bounded on the north by the Uinta uplift, on the east by the central Rocky Mountain uplift, on the south by the Uncompaghre uplift, and on the west by the Wasatch Mountain Range. In general, the vast area under consideration is called the Uinta basin; however, the term usually applied to the Colorado portion is Piceance Creek basin. Structurally, the Piceance Creek basin is separated from the Uinta basin proper by the Douglas Creek arch, which extends north-south from the Rangely area in northwestern Rio Blanco County, Colorado, to the Twin Buttes area in Rio Blanco and Garfield counties, Colorado. Of these structural features, the Douglas Creek arch and the Uncompaghre uplift have remained as stable highs since late Mississippian times.

**Sedimentary history . . .** In order to determine more favorable areas for petroleum accumulation within this vast province, it is necessary to reconstruct the sedimentary history of the area, keeping in mind factors controlling the formation of favorable reservoirs for possible accumulation of commercial quantities of hydrocarbons.

The stratigraphy of the area includes sedimentary rocks deposited from Cambrian time up to and including Tertiary time. The stratigraphic units which presently appear more favorable for future gas production are confined to rocks of Jurassic, Cretaceous, and Tertiary age, and will be discussed in more detail than the older rocks. However, in order better to understand the complete sedimentary history of the area,

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| ERA | PERIOD | SERIES | GROUP – FORMATION | THICKNESS | CHARACTER OF THE SEDIMENTS |
|---|---|---|---|---|---|
| CENOZOIC ERA | TERTIARY | | BISHOP CONGLOMERATE | 1–100 | MEDIUM TO COARSE CONGLOMERATE WITH INTERCALATED SAND |
| | | | DUCHENSE RIVER | 1435± | GRAY TO BUFF SANDSTONE AND BROWN TO RED SANDY SHALE |
| | | | UINTA (BRIDGER, COLO.) | 1725± | GRAY TO BUFF SANDSTONE AND VARIEGATED SHALES, INTERBEDDED |
| | | | GREEN RIVER | 2700± | SHALE, OIL SHALE, AND MARLSTONE, WITH GRAY TO BROWN LENTICULAR SANDSTONES<br>GAS AND OIL PRODUCTION (UINTA BASIN AND PICEANCE CREEK BASIN) |
| | | | WASATCH | 4000± | BROWN TO RED SHALES, GRAY TO BROWN SANDSTONES, CONSIDERABLE FRESHWATER LIMESTONES.<br>GAS AND OIL PRODUCTION |
| MESOZOIC ERA | CRETACEOUS | UPPER | MESA VERDE | 1700–4000± | INTERBEDDED FINE TO MEDIUM GRAINED SANDSTONE, BLACK CARBONACEOUS SHALES AND COAL. MARINE AND NON-MARINE DEPOSITION<br>(GAS SHOWS AND PRODUCTION) |
| | | | MANCOS | 5000 | SHALE, CARBONACEOUS, DARK GRAY, VERY FOSSILIFEROUS (CEPHALOPODS AND PELECYPODS)<br>SHALLOW OIL PRODUCTION AT RANGELY |
| | | | FRONTIER | 200 | GRAY TO BUFF SANDSTONE, WITH INTERBEDDED CARBONACEOUS SHALES & COAL |
| | | | MOWRY | 125 | SHALE, MARINE DARK GRAY, SILICEOUS |
| | | | DAKOTA | 0–154 | INTERBEDDED SAND, SHALE AND COAL (GAS PRODUCTION) |
| | JURASSIC | | MORRISON | 750± | VARIEGATED SHALES, SILTSTONES, & MARLS WITH INTERBEDDED LENTICULAR CONGLOMERITIC SANDSTONES. GAS AND OIL PRODUCTION – NW COLORADO |
| | | | CURTIS | 250± | SANDS & SHALES – NO GAS PRODUCTION HAS BEEN ENCOUNTERED |
| | | | ENTRADA | 200± | GRAY TO BUFF COLORED, MEDIUM GRAINED QUARTZ SANDSTONE. HIGH $N_2$ & $CO_2$ – LOW GAS |
| | | | CARMEL | 65± | RED SILTSTONE & CALCAREOUS SHALES, GRADING FROM MARINE NON MARINE EASTWARD |
| | | | NAVAJO | 450± | BUFF TO RED STRONGLY CROSS-BEDDED SANDSTONE FORMATION RAPIDLY THINNING FROM NORTH TO SOUTH |
| | TRIASSIC | | CHINLE | 200± | PREDOMINANTLY RED SHALES MARLS & SILTSTONES OF FRESH WATER ORIGIN. NO PRODUCTION HAS BEEN ENCOUNTERED |
| | | | SHINARUMP | 80± | SANDS, MUDSTONES, AND CONGLOMERATES ONE OIL WELL IN RANGELY FIELD |
| | | | MOENKOPI | 750± | RED GYPSIFEROUS CALCAREOUS SHALES & SILTSTONES ENCOURAGING SHOWS OF GAS & OIL IN THE NORTH PLUNGING NOSE OF THE SAN RAFAEL SWELL |

(Continued on opposite page.)

GENERALIZED STRATIGRAPHIC COLUMN—NE UTAH & NW COLORADO (Continued)

| ERA | PERIOD | SERIES | GROUP – FORMATION | THICKNESS | CHARACTER OF THE SEDIMENTS |
|---|---|---|---|---|---|
| PALEOZOIC ERA | PERMIAN | | PARK CITY (PHOSPHORIA) | 87 | LIMESTONE. LITTLE PROMISE FOR OIL OR GAS. ONE WELL PRODUCES FROM THE PHOSPHORIA IN ASHLEY VALLEY FIELD |
| | PENNSYLVANIAN | UPPER | WEBER | 1100 | WHITE TO LIGHT GREY FINE GRAINED SANDSTONE WITH SOME RED & MAROON SHALES INCREASING WITH DEPTH. MOST PROLIFIC OIL PRODUCER IN THE SUBJECT AREA. PRODUCTION FROM THE TOP 60'–100' |
| | | MIDDLE | MORGAN | 1200 | GREY LIMESTONES, WEATHERING RED WITH CONSIDERABLE SANDSTONE BEDS IN THE UPPER PART. CHERTY LIMESTONES, DARKER IN COLOR, IN LOWER PART. THINS RAPIDLY FROM NORTH TO SOUTH ALONG THE UTAH-COLORADO BORDER |
| | | | MOLAS (?) | 20± | EROSIONAL UNCONFORMITY BETWEEN MISSISSIPPIAN & PENNSYLVANIAN FORMATIONS |
| | MISSISSIPPIAN | | MADISON (LEADVILLE) | 600±(?) | BUFF TO DARK GREY POROUS LIMESTONES & DOLOMITES. BELIEVED MADISON OFFERS EXCELLENT POSSIBILITIES FOR COMMERCIAL GAS & OIL |
| | DEVONIAN | | OURAY (ELBERT) | 200± | GREY DOLOMITE. OIL SHOWS REPORTED IN THE COLORADO PLATEAU AREA |
| | ORDOVICIAN | | MANITOU | 50± | WHITE TO GREY DOLOMITIC LIMESTONE. VERY FINELY CRYSTALLINE. NO PRODUCTION TO DATE |
| | CAMBRIAN | | SAWATCH (PEERLESS SHALE) (OPHIR SHALE) | 3000(?) | SAWATCH – QUARTZITIC<br>OPHIR – GREEN SHALE. DOES NOT OFFER GAS OR OIL POSSIBILITIES IN THIS AREA |
| ARCHEOZOIC ERA | PRE-CAMBRIAN | | UINTA MOUNTAIN GROUP | 10,000 | SCHISTOSE AND GNEISSIC ROCKS UNDERLIE ALL OF NORTHEASTERN UTAH AND NORTHWESTERN COLORADO. YOUNGER PRE-CAMBRIAN ROCKS EXPOSED IN UINTA MOUNTAINS ARE COMPOSED OF A THICK COMPLEX OF METAMORPHOSED SEDIMENTS |

the rocks of Paleozoic and early Mesozoic age will be discussed briefly.

### Pre-Cambrian

Rocks of pre-Cambrian age underlie all of northeastern Utah and northwestern Colorado and are exposed in the core of the Uinta Mountains and the Wasatch Mountains, where they may be described as basement complex rocks and younger pre-Cambrian rocks consisting primarily of quartzites and argillites.

### Paleozoic

The Paleozoic era is represented in this area by Cambrian, Ordovician, Devonian, Mississippian, Pennsylvanian, and Permian sediments.

**Cambrian . . .** Three thousand feet of green shale exposed in the Uinta Mountain Range has been assigned to the Cambrian period and is believed to be equivalent to the Ophir formation of the Central Wasatch Mountains, which contains fossils of both lower and middle Cambrian times. The Cambrian does not offer oil or gas possibilities.

**Ordovician . . .** Fifty-eight feet of the Manitou formation, a white to gray, dolomitic, finely crystalline limestone of Ordovician age has been described in General Petroleum Co.'s 1 Schulte well, 15-6s-103w, Garfield County, Colorado. The Manitou formation is recognized over a large area on both sides of the front range, but no production has been found to date in the Manitou, and it does not have promising possibilities as a potential reservoir rock.

**Devonian . . .** Rocks of Devonian age do not outcrop in this immediate area, but approximately 175 ft. of questionable Devonian was topped at a depth of 7,730 ft. in the General Petroleum Schulte well. To date, rocks of Devonian age have not been an attractive zone for exploration in the area. However, Devonian oil shows have been reported in the Colorado plateau area. It is thought oil-production possibilities in the Devonian are greater than its gas possibilities.

**Mississippian . . .** The Mississippian period is represented in this area by the Madison formation, consisting of approximately 600 ft. of buff to dark gray porous limestones and dolomites. To date, one well, General Petroleum Co.'s 1 Schulte, has penetrated the Madison formation. The Madison was encountered at a depth of 7,364 ft. from the surface, or a datum depth of minus 924 ft. Presently The Texas Co. is drilling a well in Rangely field to test the Madison. It is believed the Madison offers excellent possibilities for oil and associated gas production in the area of the Douglas Creek arch. There is, however, a definite thinning of the Madison from north to south along the area of the Douglas Creek arch.

**Pennsylvanian . . .** The Pennsylvanian period is represented by the Molas, Morgan, and Weber formations. The Molas formation represents an erosional unconformity between Mississippian and Pennsylvanian times; however, the Molas has been identified in the area under consideration only along the southern part of the Douglas Creek arch in the General Petroleum Co. 1 Schulte well.

The Morgan formation thins rapidly from north to south along the Colorado-Utah boundary, measuring approximately 1,200 ft. in the Split Mountain area of the Uinta arch near the Colorado-Utah boundary, to zero in the Carbonera anticline in Mesa County, Colorado. The Morgan formation is described as gray limestone, weathering red with considerable sandstone beds in the upper part. Cherty

THE AUTHOR

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limestones, darker in color, occur in the lower portion. No shows have been encountered in the Morgan to date.

The Weber formation is approximately 1,000 to 1,200 ft. thick, and consists of white to light-gray, fine-grained sandstone with some red and maroon shales. The Weber has some arkosic beds near the base of the formation and is predominantly arkose in the Twin Buttes area. Production to date from the Weber has come from the top 60 to 100 ft., and production to date has been oil, with the gas-oil ratio relatively low. The Weber formation is the most prolific production formation in the subject area. Rangely field and Ashley Valley field in central Uintah County, Utah, both produce from the Weber, but its commercial possibilities appear to be primarily oil.

**Permian . . .** The Permian period is represented in this area by the Park City limestone and possibly some of the Phosphoria. In the Split Mountain area, previously referred to, 87 ft. of Permian has been measured, but only 10 to 20 ft. has been logged in Rangely field. Continental Permian deposits outcrop throughout the Colorado plateau area and are believed to underlie the western part of the Uinta basin. The Phosphoria produces oil from one well in Ashley Valley field.

### Mesozoic

All periods of the Mesozoic are represented in the area. However, rocks of the Jurassic and Cretaceous periods have the best gas possibilities and will be discussed in more detail.

**Triassic . . .** The Triassic period is represented by the Chinle, Shinarump, and Moenkopi formations. The Moenkopi formation, over most of this area, is approximately 750 ft. thick and consists of red gypsiferous, calcareous shales and siltstones. The Sinbad member of the Moenkopi is present along the north-plunging nose of the San Rafael swell and has been reported to have had encouraging shows of gas and oil. However, the Sinbad member is predominantly marine and does not extend under the area of discussion.

The Shinarump formation is composed of sands, mudstones and conglomerates derived from sources external to the basin proper. It averages approximately 70 to 100 ft. in thickness and has produced oil in Rangely field. The Shinarump formation is an excellent marker bed in western Colorado and eastern Utah.

The Chinle formation is predominantly red shales, marls, and siltstones of fresh water origin, varying from 130 to 210 ft. in thickness and has had no production or encouraging shows of oil or gas.

**Jurassic . . .** The Jurassic period is represented in the area by the Navajo, Carmel, Entrada, Curtis, and Morrison formations.

The Navajo formation is a buff to red, strongly crossbedded sandstone, for the most part eolian and medium-grained. The formation in the area thins rapidly from north to south. There has been 728 ft. measured in the Split Mountain area and 317 ft. logged in the Twin Buttes area. The Navajo has been tested in several wells in this area and does not appear to have extensive possibilities in the Uinta and Piceance Creek basins for gas production.

The Carmel formation averages approximately 65 ft. in thickness and is composed primarily of red siltstone and calcareous shale, grading from marine to nonmarine eastward from the Colorado-Utah state line.

The Entrada formation is light-gray to buff, medium-grained, uniform quartz sandstone of eolian deposition. The Entrada increases in thickness from the Split Mountain area, where it measures approximately 100 ft., to the Twin Buttes area, where approximately 240 ft. has been logged. Gas has been encountered in several areas in western Colorado and eastern Utah; however, the carbon dioxide content and nitrogen contents of the gas have been extremely high in most cases. The Entrada formation in the Uinta basin has tested gas in volumes sufficient to be commercially productive in the Bar-X area at a depth of approximately 3,600 ft., in the Twin Buttes area at approximately 7,128 ft., and in the Garmesa-Carbondera area at approximately 3,515 ft. However, in the Bar-X and Garmesa areas the carbon dioxide and nitrogen contents of the gas have been extremely high, varying from 20 to 60 per cent. Although the Greenbrier Oil Co. 1 Federal, discovery well in the Twin Buttes area, tested in excess of 7,000,000 cu. ft. of 997-B.t.u. gas, a subsequent Entrada test has revealed extremely high $CO_2$-low-B.t.u.-content gas.

The Curtis formation, deposited under a marine invasion, left its maximum thickness of sediments in the eastern portion of the Uinta basin. Glauconite and belemnites are characteristic of the Curtis. The Curtis formation in the Split Mountain area is 253 ft. thick and is composed of sands and shales. No production to date has been encountered in the Curtis, and the Curtis does not appear favorable for commercial production.

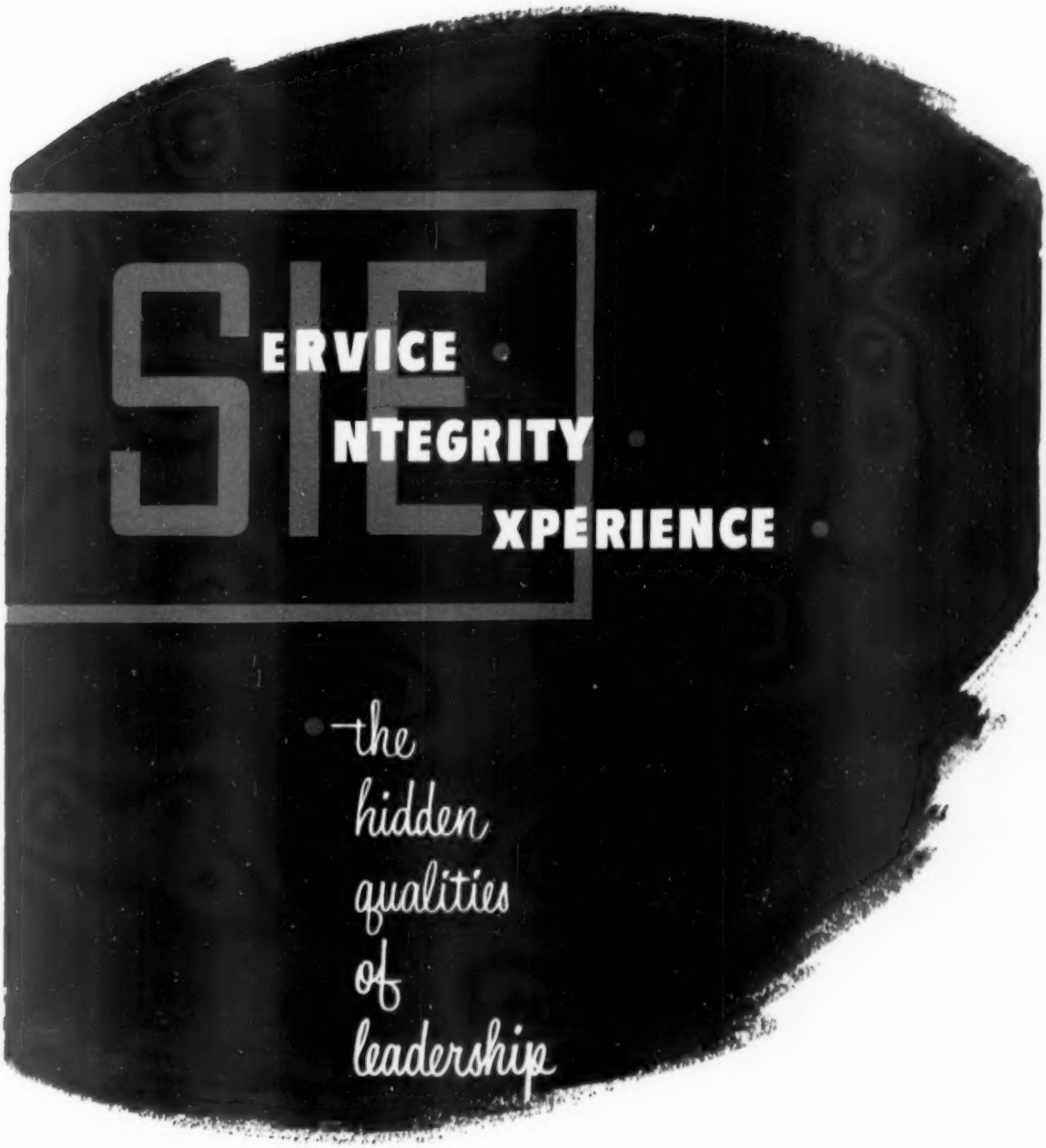
The Morrison formation is composed of variegated shales, siltstones, and marls with interbedded conglomerate sands. Commercial gas production has been in sand lenses of the upper Morrison and the basal Morrison, sometimes referred to as the Salt Wash member. Oil has also been found in the Morrison in northwestern Colorado. The accumulation of commercial deposits of oil and gas in the Morrison has been primarily stratigraphic and is dependent upon sand lensing and porosity variations. The Morrison has tested gas in sufficient volumes to be commercial in the Bar-X area at a depth of approximately 3,600 ft. Morrison gas has also been produced in the Ashley Valley area of the Uinta basin. Numerous other Morrison gas shows throughout the Piceance Creek basin indicate potential commercial Morrison gas production from sands of sufficient thickness and gas of sufficiently high B.t.u. content.

An erosional unconformity exists between the Morrison and overlying Dakota formation and it is suggested that the source bed for the Morrison is the overlying interbedded shale and coal members of the Dakota.

**Cretaceous . . .** The Cretaceous period is represented by the Dakota, Mowry, Frontier, Mancos, and Mesaverde formations.

The Dakota formation is one of the most widespread formations in the Rocky Mountain region. In northeastern Utah and northwestern Colorado the Dakota ranges from zero to 150 ft. in thickness and is composed of interbedded sand, shale, and coal. In eastern Utah and western Colorado the basal part of the Dakota is represented by a thin conglomerate, locally known as the Buck Horn member, and is a particularly valuable marker in the area. It represents an erosional unconformity between the Cretaceous and Jurassic periods. Sands of the Dakota formation have been gas bearing in several areas of this region, namely the Bar-X, Douglas Creek, Twin Buttes, Garmesa-Carbondera, Asbury Creek and Highline Canal areas. However, Dakota sands vary laterally rapidly according to porosity and permeability characteristics, thus reflecting deposition in a shallow fluctuating sea. The Dakota gas to date has been found to contain carbon dioxide and nitrogen in relatively minor varying amounts, but has a uniformly higher B.t.u. content than gas thus far found in the Entrada.

The Mowry, or lower Mancos, is present in northwestern Colorado and in the eastern part of the Uinta basin portion of Utah. At the outcrop in the Split Mountain area it is 125 ft. thick, and is described as a dark-gray, hard siliceous marine shale, weathering silver

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gray and containing abundant fish scales.

The Frontier formation is represented over most of this area, averaging about 200 ft. in thickness. The Frontier is a buff to gray marine and continental sandstone with considerable interbedded carbonaceous shales and coals representing considerable fluctuation of deposition. The development of the sands varies considerably. There has been no production to date from this formation in the Uinta basin, although several encouraging shows have been encountered in northwestern Colorado. To the north of this area in the Green River basin of southwestern Wyoming, the Frontier promises to be a potentially large gas-producing formation. The Frontier appears to grade from a well-developed sand in the Green River basin area of southwestern Wyoming, and the southern flank of the Uinta Mountains, to a shale facies in the Uinta basin proper.

The Mancos shale formation is represented in the area by approximately 5,000 ft. of dark carbonaceous shale, very fossiliferous with cephalopods and pelecypods being the most abundant. The Mancos shale represents a time of little or no diastrophism. Shallow oil has been produced at Rangely from fractured zones in the Mancos shale.

The Mesaverde formation is represented in this area by 1,700 to 4,000 ft. of sandstone, shale, and coal deposited under both marine and continental conditions. A complete detailed description of the Mesaverde is not of importance here; however, it is believed that the interbedded sand members of the Mesaverde offer one of the best gas possibilities in the area. Mesaverde gas shows have been encountered in numerous wells in the northeastern Utah-northwestern Colorado area. Completion methods appear to be the most important factor for future Mesaverde production. Only two areas have completed commercial gas wells in the Uinta basin, the Hell's Hole area and the White River dome area in Rio Blanco County, Colorado. The sands in the Mesaverde formation appear to be very low in porosity and permeability. In general, it is thought the Mesaverde has excellent possibilities for future gas reserves in both the Piceance Creek basin and the Uinta basin, where drilling depths are reasonable.

### Cenozoic

The Cenozoic era is represented in the area by Tertiary deposits over the greater portion of the area and quaternary alluvium deposits.

**Tertiary . . .** Tertiary sediments of continental origin cover the greater portion of the area and are represented by the Wasatch, Green River, Uinta, Duchesne River, and Bishop conglomerate formations.

The Wasatch formation, which grades transitionally with the underlying Mesaverde formation of Cretaceous age, extends from the Soldier's Summit area of central Utah along the Book Cliffs escarpment through eastern Utah and into western Colorado with the thickness varying from 4,000 ft. plus to approximately 250 ft. Along the Douglas Creek arch, which separates the Uinta and Piceance Creek basins, the Wasatch thins considerably; however, in the Piceance Creek basin proper, in excess of 3,500 ft. of Wasatch has been measured, but is thought to thicken to possibly 6,000 ft. in the axis of the Piceance Creek basin. The over-all section of Wasatch consists of red shales, gray to brown sandstones, with fresh-water limestones throughout the formation. Speiker has assigned the names of North Horn, Flagstaff, and Colton members to the Wasatch formation. Wasatch gas production to date has come primarily from the upper Wasatch and overlying Green-River-Wasatch transition zone.

The Green River formation overlies the Wasatch formation and the contact is transitional. The Green River formation is primarily lacustrine deposition. In the Utah portion of the Uinta basin the Green River formation has been divided into four members—the basal member, the delta facies, the oil horizon, and the shale facies. In tracing the formation from the east to the western portion of the basin, considerable intertonguing with the Wasatch formation has been noted, both in outcrops in the Indian Canyon, Utah, area and from well logs in the Peters Point area. The Green River formation averages approximately 2,700 ft. in thickness, having its greatest measured thickness in Indian Canyon, Utah, approximately 4,900 ft. The over-all Green River formation can be described as shale, oil shale and marlstone, gray to grayish-brown with lenticular gray to brown sandstones. Gas encountered in the Green River formation, the Green River-Wasatch transition zone, and the Wasatch formation proper has had uniformly low carbon dioxide and nitrogen contents. Gas being encountered in the Peters Point area of Carbon County, Utah, has a B.t.u. content of 1,000 in sands in the transition zone at a depth of approximately 3,000 ft. and a B.t.u. content of 1,100 in middle Wasatch sands found at a depth of approximately 4,800 ft. Gas wells are presently completed in the Piceance Creek area in Green River sediments and sands of the Green River carry gas of commercial quality and volume in the Red Wash area.

The Uinta formation of upper Eocene age is conformable with both the overlying Duchesne River and the underlying Green River formation. It is an interbedded gray to buff sandstone and variegated shale. The formation averages approximately 1,725 ft. in thickness. There has been no production from the Uinta formation to date.

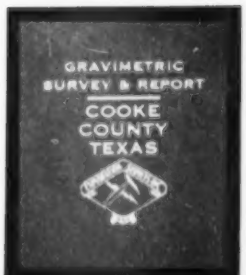
The Duchesne River formation of upper Eocene, or possibly lower Oligocene, covers the north flank of the Utah portion of the Uinta basin. It is an interbedded gray to buff sandstone and brown to red sandy shale, averaging approximately 1,435 ft. in thickness. The Bishop conglomerate covers various areas in the northeastern part of the Uinta basin. It unconformably overlies formations from Cambrian to Eocene age. It is a poorly sorted medium-to-coarse conglomerate with intercalated sand, varying in thickness from 1 ft. to 10 ft. It is considered from Miocene to Pliocene in age.

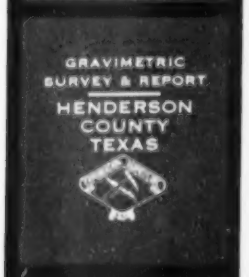
### Summary

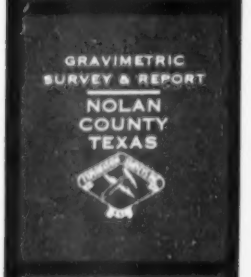
These broad classifications and generalizations are intended to show the relative valuation of this large area, based on sedimentation, structural features, and reasonable drilling depths for frontier exploration. Commercial gas discoveries and numerous gas shows in favorable sediments of Jurassic, Cretaceous, and Tertiary ages, together with favorable reservoir and source rocks and traps for accumulation, lend encouragement to the Uinta and Piceance Creek basins containing sizable deposits of future gas reserves.

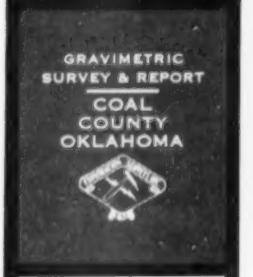
However, the usual problems accompanying an area where sediments of both marine and nonmarine origin occur—that is, (1) questionable reflection of surface structural features at depth, (2) rapid lateral porosity and permeability variations, and (3) deposition of sands with thickness sufficient to provide large reserves—are present in northeastern Utah and northwestern Colorado in disturbing regularity. In addition to the above "normal" accompanying problems, the occurrence of low-B.t.u.-content gas, due to the large amounts of carbon dioxide and nitrogen present, presents additional problems.

Nevertheless, it is felt large gas reserves will be proved in the area if (1) wells are drilled to the proper objectives in areas where frontier exploration is not condemned by excessive depth, and (2) extraordinary sedimentation studies, particularly regarding sand development, carefully precedes locations for gas wells.

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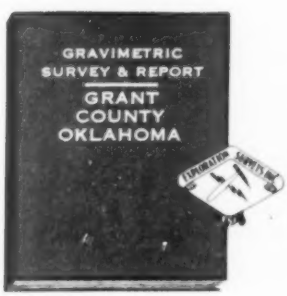


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| FISHER | REFUGIO |
| GOLIAD | RUNNELS |
| GRAYSON | SCURRY |
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| CARTER | JEFFERSON |
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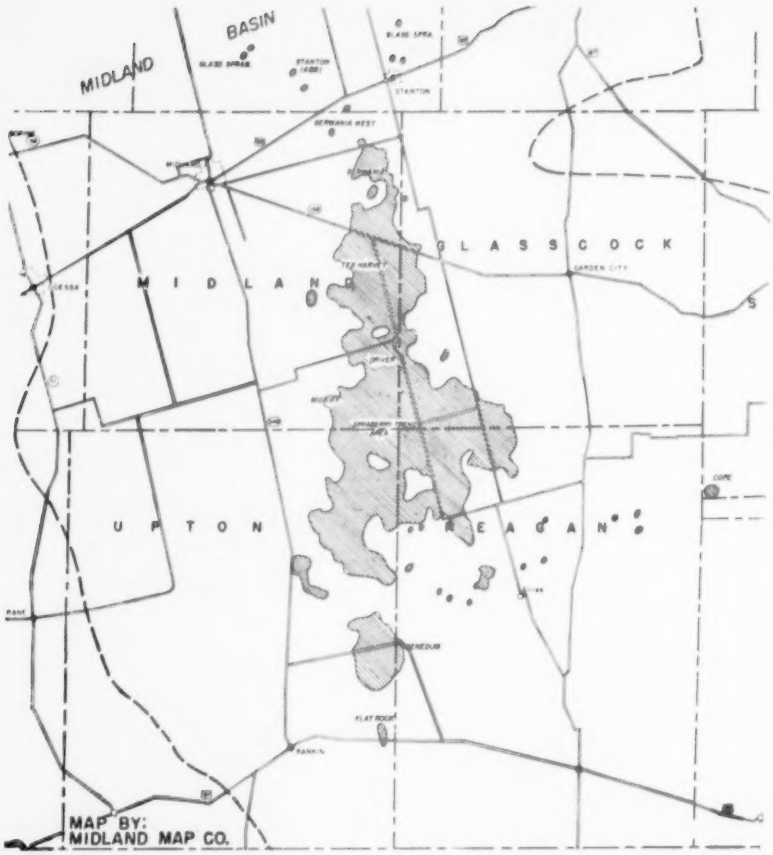
| GREER | STEPHENS |
| HARMON | TILLMAN |




**Areal extent of the Spraberry Trend Area field in the Permian basin of West Texas.**

## A SEARCHING LOOK AT

# THE SPRABERRY TODAY

"... through use of a larger spacing program and new stimulant techniques, future development will be greatly accelerated and a revamped economic outlook will result."

**by J. H. Bartley**

SINCE completion of the first Spraberry producer in West Texas, Seaboard Oil Co. 2-B Lea (discovery well of Spraberry Deep field of Dawson County, Texas), development from this horizon has been of a highly controversial nature. Tex Harvey 1 Floyd was the discovery well of Tex Harvey field of Midland County, being completed February 24, 1949, and was likewise the discovery well of the present Spraberry Trend Area field, which covers a four-county area located in Glasscock, Midland, Reagan, and Upton counties.

At midyear 1951, there were approximately 300 wells producing from the Spraberry and 160 drilling wells in 20 different producing areas. As of March 1, 1952, this same area contained 1,223 wells producing from the Spraberry sandstone section, and had produced cumulative total of approximately 25,580,000 bbl. of oil with a monthly rate of production being approximately 2,250,000 bbl. of oil.

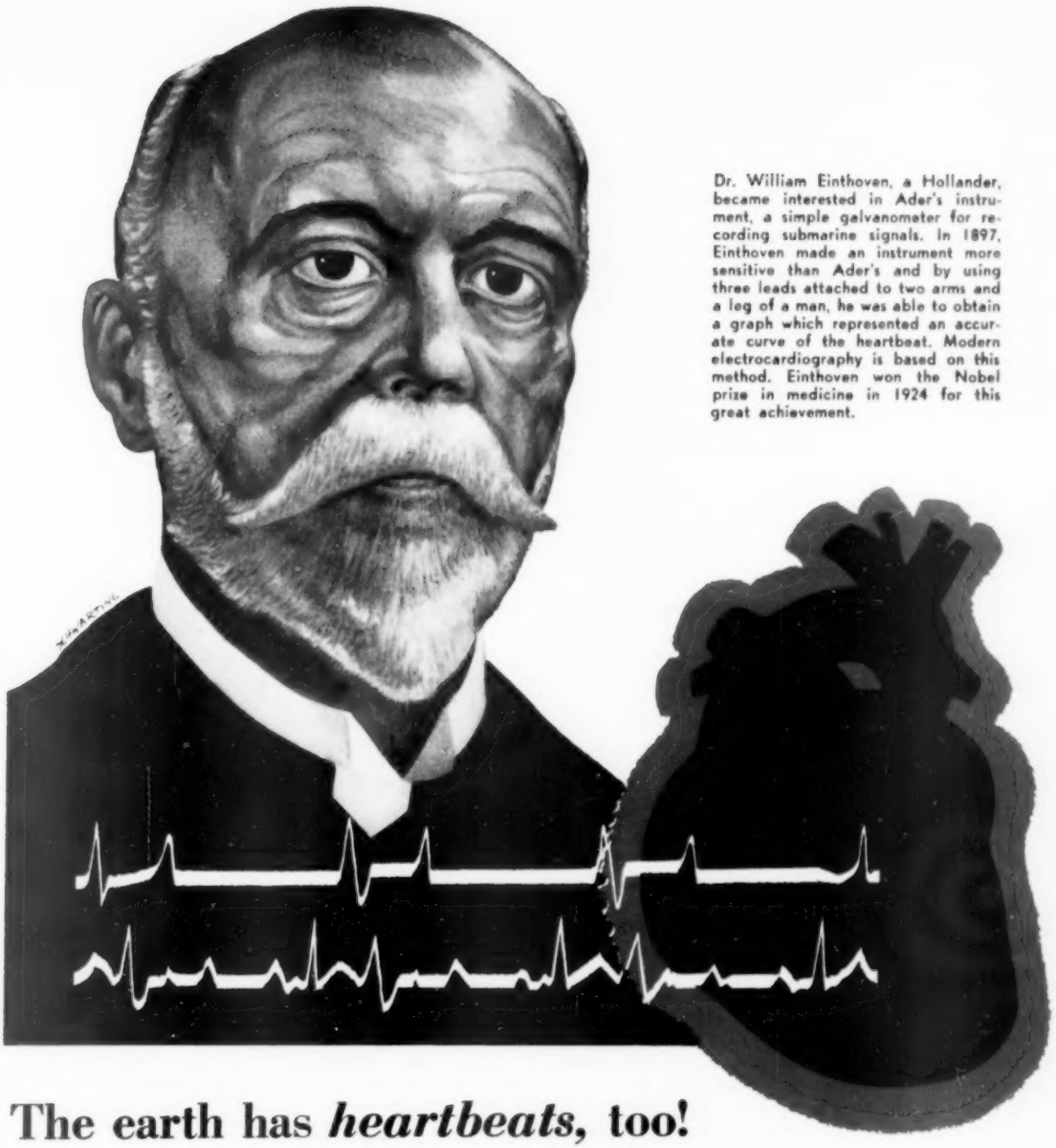
**The boom ...** The year 1952 witnessed what was known as the Spraberry "boom." During this time there were about 300 to 325 rigs operating throughout the trend area of the four counties. In the period from February 1949 to December 1952, development of this vast Spraberry producing area was from both the upper and lower Spraberry on 40-acre spacing. However, it was becoming evident that the wells should be located on a wider spacing program; bottom-hole pressures were dropping rapidly in the areas drilled on 40-acre spacing, compared to wells drilled on 80-acre units which had a lesser decline in bottom-hole pressure compared to barrels of oil produced. As of February 1, 1953, the Spraberry Trend had produced a cumulative total of 51,086,426 bbl. of oil from 2,229 producing wells.

As of December 22, 1952, a special order was issued by the Texas Railroad Commission; it became effective March 1, 1953, and changed the allowables on the wells so that they were based 75 per cent on acreage and 25 per cent on per well for wells drilled prior to December 22, 1952, on 40-acre units. All future producing wells were allocated on 80 and 160-acre proration units. The previously drilled 40-acre units and the future 80-acre units were given an allowable of 121 bbl. of oil per permissible producing day; the 160-acre units were given an allowable of 212 bbl. of oil per permissible producing day. Also, effective March 1, 1953, the commission recognized a new field name (Spraberry Trend Area) for proration purposes.

**Field shut in ...** On April 1, 1953, the Railroad Commission shut in all Spraberry producing properties. There was a lack of outlets for residue gas, and the order was necessary to prevent further flaring of gas from wells which had no gas connection.

Those operators having gas connections at that time carried their case to the Supreme Court of Texas and received a ruling that they should be permitted to produce. In these cases the Railroad Commission gave the operators a permissible production schedule of 11 days per month, which was an allocation based on the capacity of plants in the area for residue gas. This producing schedule was maintained until January 1, 1954, at which time all Spraberry producing wells in the Spraberry Trend Area were permitted to produce on the regular state-wide monthly allowable pattern.

**Production restored ...** By December 1953, sufficient gas-processing plants and gas pipeline outlets for the trend



Dr. William Einthoven, a Hollander, became interested in Ader's instrument, a simple galvanometer for recording submarine signals. In 1897, Einthoven made an instrument more sensitive than Ader's and by using three leads attached to two arms and a leg of a man, he was able to obtain a graph which represented an accurate curve of the heartbeat. Modern electrocardiography is based on this method. Einthoven won the Nobel prize in medicine in 1924 for this great achievement.

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THE AUTHOR

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area were completed, and regular production for the Spraberry was restored. One of the largest gas-gathering systems known to date was completed in the shortest time possible to facilitate the return of the Spraberry Trend Area to active production. The combined efforts of three natural-gas companies, three gas-distributing firms, and one petroleum company made this system possible. A comparison of the production rates from the trend area before and after the shut-in follows:

| Month— | Production | Allowable days | Prod. wells |
|---|---|---|---|
| 1953 January | 2,715,674 | 22 | 2,088 |
| 1954 January | 2,326,594 | 17 | 2,229 |

Note: This production does not include Benedum Spraberry which produced a cumulative total of 2,888,727 bbl. as of February 1, 1954, from 144 wells, and during the month of January 1954 produced 239,916 bbl. of oil.

**Effects of the shutdown . . .** It should be noted that the percentage of production relative to the number of allowable days on the comparative months does not vary too much; however, it is known that a small percentage of the wells was hurt by the shutdown, especially those that had no gas connections during the shutdown period and were not able to produce at all. Some of these wells were found to be water logged, and it became necessary to pump off the water standing in the holes; however, they did produce, but not at the same rate as before the shutdown. It was this condition, in addition to rapid drops in bottom-hole pressures, coupled with increasing gas-oil ratios, that brought about investigations into the feasibility of new methods to stimulate oil and gas production from the Spraberry.

### New Methods of Stimulating Oil and Gas Production

**1. Water-imbibition displacement process . . .** This process was undertaken by Atlantic Refining Co. at its properties located in Driver field, Midland County portion of the Spraberry Trend Area, in early 1953. The process consisted of introducing water into the Spraberry producing horizon, assuming that the reservoir would imbibe water and displace oil sufficiently fast to maintain the production rate desired; this in turn would reduce rapid drops in reservoir pressure. The water imbibition idea was based on the theory that the oil, stored in a water-wet matrix such as the Spraberry, would imbibe water and release oil. This condition also required the presence of fractures, also characteristic of the Spraberry section. This project in the Driver area was exempted from the shutdown because of the need for a continued rate of water input in the producing horizon.

To date the results of this experiment are not too conclusive; however, there was a period in the early stages of this experiment during which bottom-hole-pressure drops were arrested in comparison to other areas, with the same rates of withdrawal.

**2. New "frac" technique . . .** This new technique was developed by engineers of Southern Production Co. and Dowell Incorporated and has indicated that Spraberry wells treated with this new method of hydraulic fracturing will show lasting benefits in production. The technique consists of treating with an average of 20,000 gal. of frac with 1½ lb. of sand per gallon, using large-volume, high-injection-rate treatments to increase penetration into the Spraberry fractures; all this necessitates large-capacity pumping equipment so that injection rates of 30 to 50 bbl. per minute can be maintained using a maximum treating pressure of approximately 2,000 psi.

This new method was first used in June 1953, and has since been successfully employed on 25 wells in the Spraberry Trend Area; 23 of these were producers ranging in age from 1 year to 18 months, having initial potentials of 125 to 450 bbl. of oil per day, and whose average daily production had dropped to an average of 10 to 25 bbl. of oil per day.

Most of these wells were treated with an average of 20,000 gal., after which they were potentialed for an average range equivalent to their original potentials or higher. Two of these wells were given the large fracturing job initially, prior to their original potential test. One of these was completed recently for over 1,200 bbl. of oil per day; the second well is now in the process of completion after using 21,000 gal.

**3. Surface-tension reduction . . .** As previously mentioned, there were numerous wells in the Spraberry Trend Area which were shut in for the last 7 months of 1953 during the shut-in period awaiting gas connections; during this time these wells became water logged. When operators reopened these wells for production, some found as much as 3,000 ft. of water standing in the hole and upon removing the water it was found that the productivity of these wells had dropped to only a few barrels of oil per day. Three or four wells have been treated with Surfactant, a trade name for a fluid mixed with lease oil that is pumped into the formation to reduce the surface tension of the exposed formation and in turn to permit the flushing out of water present in the open fractures adjacent to the bore hole.

### Reservoir Observations

A study of the reservoir characteristics of the older producing Spraberry properties such as Driver, Four-Corners area, Tex Harvey, Tippett, and Benedum, indicates that allowables can be maintained until such time as an average bottom-hole pressure of 1,500 psi. has been reached. At this time, usually, all of the oil will have been produced from the fractures and production from the matrix rock commences with increasing gas production and a rapid decline in production of oil. It has been observed that the bubble point of the lower Spraberry ranges from 1,850 to 1,950 psi. bottom-hole pressure; however, it has been noted that gas-oil ratios do not rise excessively until an average of 1,500 psi. b.h.p. has been reached.

A comparison of bottom-hole pressure versus production-decline curves in the aforementioned older Spraberry producing areas, indicates that declines are rather uniform and slow until approximately 1,500 psi. b.h.p. is reached, at which point the rate of decline is rather rapid. Calculations indicate that production decline from 1,500 to 800 psi. b.h.p. occurs at the average rate of 5 per cent of the previous month's production per month for the lower Spraberry and 10 per cent of the previous month's production per month for the upper Spraberry. It has also been calculated that upon reaching an average of 800 psi. b.h.p. individual wells cannot produce more than about 120 bbl. of oil per month, and the excessive gas-oil ratios that result necessitate classifying them as gas wells.

**Economic limit . . .** An average of 120 bbl. of oil per well per month is calculated as the usual economic limit for operation; however, this figure can vary with respect to the number of wells on a common lease and the individual operator's lifting cost, not to

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mention the gas capacity of these wells when they reach an economic oil-production limit. It has been observed that wells drilled on 40-acre units had much more rapid decline in bottom-hole pressure than wells drilled on 80 to 160-acre units. There is an indication that the average drop in bottom-hole pressure in wells located on 40-acre units compared to wells drilled on 160-acre units is practically in ratio to the acreage unit per well. In other words, wells on 80-acre units would decline 50 per cent as fast as wells on 40-acre units, and those on 160-acre units only 25 per cent as fast as wells located on 40-acre units.

Various properties observed throughout the trend area which were developed on 80 to 160-acre units, and which have been on continuous production for the past 12 to 16 months (when their monthly allowable schedule ranged from 11 to 18 producing days per month) have indicated an average production of 150 bbl. of oil per pound drop in bottom-hole pressure. From this, an average initial bottom-hole pressure of 2,200 psi. would indicate an average primary recovery of 1,800 bbl. of oil per acre for wells drilled on 80-acre units.

In the early days of Spraberry development it became apparent that the capacities of the wells would vary directly with the degree of fracturing adjacent to the bore hole, whether it be the upper or lower Spraberry section, and it was observed that these fracture patterns were more or less oriented northeast and southwest.

The areal extent of these highly fractured areas is also variable. It ranges from 160 acres in the Tex Harvey district to 1,200 and 1,400 acres in the Four-Corners district common to Glasscock, Reagan, Midland, and Upton counties. East of this area, along the Glasscock-Reagan line, the high fracture areas become smaller in areal extent and pass southward in the newer developed portion of the Aldwell area. The fracture areas become larger and extend generally north-south, and cover areas of 1,200 to 1,400 acres.

**Contouring on potentials . . .** It is possible to contour using the potentials of individual wells as data throughout the Spraberry Trend Area. Prior to using the well potential as a factor, it is wise to correct it with respect to the amount of Hydrafrac or acid used. Also, the size choke and section from which the production occurs (i.e., upper or lower Spraberry) should be considered, as well as the operator of each individual property; therefore, each well potential is reduced to a common base.

After a contoured initial potential map has been prepared, it is also advisable to determine the percentage of the total current monthly lease production to its total allowable with respect to whether the well is located on a 40, 80, or 160-acre unit. Therefore, by inclusion of the percentage production of the total allowable of a lease, in conjunction with a study of the contoured potential of the area, it is possible to determine those areas which should be studied for use of the large fracture job. In other words, properties which had an initial high potential and were associated in a high potential-high fracture area, which showed small monthly production, would be more selective for the large fracture job than those wells in low potential areas indicating position in a low-fracture area.

It has been found that a contour map using the potential factors will show the areal extent, more or less, of these high fracture-high potential areas throughout the Spraberry Trend Area, and this method can be used to predicate the presence of undeveloped high fracture-high potential areas where sufficient "potential" control is available.

Currently, the trend contains 37 active rigs with completions ranging from 10 to 12 per month.


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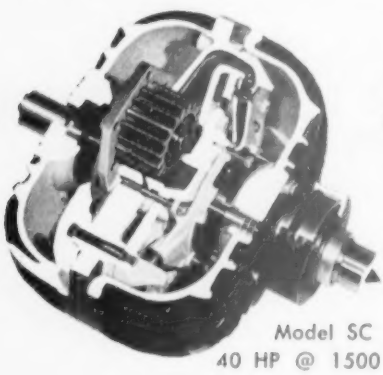

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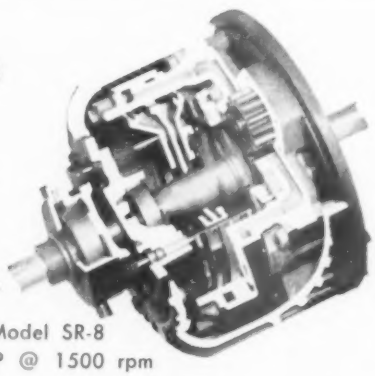

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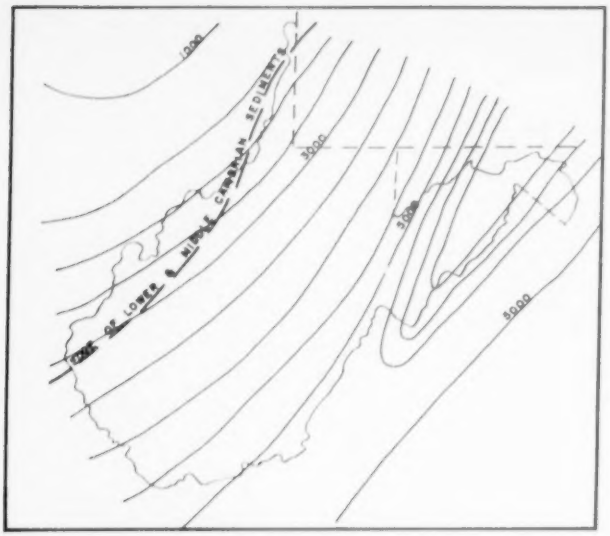


Fig. 1—This highly generalized sketch map suggests a possible interpretation of Cambrian thickness throughout West Virginia. It is largely inferential, for there are almost no control points. The location of the western edge of early Cambrian deposition is our conjecture. Adapted from Figs. 7, 8, 9, Herbert P. Woodward.[1]

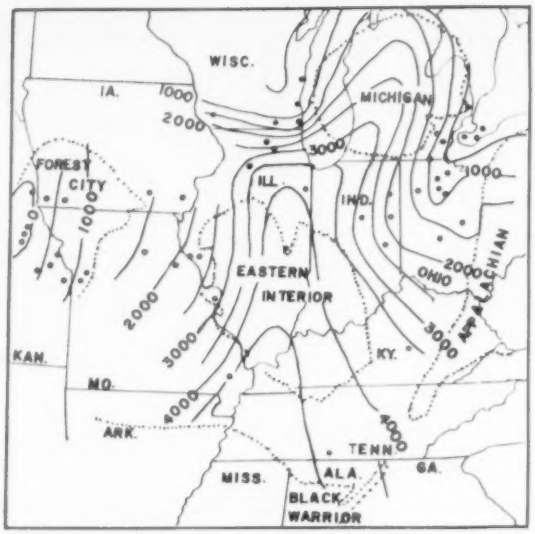


Fig. 2—Adapted from Illinois State Geological Survey, Circular No. 169, "Future Oil Possibilities of the Eastern Interior Basin," by Swann, Henderson, Combs, Escarey, Freeman, Jones & Thwaits, 1951, p. 496, Fig. 153.

# Cambrian Looms as Important '54 Target

## *Depth ranges from 3,100 ft. in Kansas to 7,500 in Rockies*

**by J. H. McCammon**

MANY producing areas of the United States have some single period of deposition which accounts for the majority of the production. In the Appalachian area it has been the Devonian, in the Eastern Interior basin—the Mississippian, and on the West Coast, the Tertiary. No producing area as yet has Cambrian sediments yielding the greater part of the production but Cambro-Ordovician rocks hold a very respectable production position in the Mid-Continent area.

Crediting Cambrian rocks with part of this production leads to an indeterminable problem, because the deposition of Arbuckle or Ellenburger sediments started in Upper Cambrian and continued into the Ordovician period. The erosional hiatus found, then, in many fields at the top of this carbonate series leaves considerable doubt concerning the age of the producing section of these strata. The pay may be Cambrian and/or Ordovician. To avoid this problem, it is the intent of this paper to restrict discussion of Cambrian production to pre-Ellenburger or pre-Arbuckle producing horizons.

The Cambrian sediments have been penetrated in almost every basin in the United States which produces from Paleozoic rocks. Commercial production, however, from the Cambrian is restricted to three western states of Kansas, Texas, and Wyoming. For the most part, the discovery of Cambrian production in these three areas is the result of deeper drilling in producing fields. East of the Mississippi River, deeper drilling on known producing structures has stopped most frequently in the Ordovician. Cambrian tests have had shows, however, over a wide area.

### Appalachian Geosyncline

Cambrian sediments, and in large part marine, may reach a total thickness of over 5,000 ft. in the Appalachian geosyncline (Fig. 1). This area, producing oil since Drake's discovery, has seen only one or two tests in the deeper part of this basin. The new New York State Natural Gas Corp. 1 Kesselring, an 11,145-ft. test in New York State, set somewhat of a cable-tool depth record in cutting some 1,109 ft. of Upper Cambrian sediments. The sample description of this section reveals similarities with the section on the Eastern platform of Texas. The majority of the other tests penetrated the Cambrian at much shallower depths. Shows of oil and gas in the Cambrian have been encountered in eastern Kentucky, East-Central New York, southern Ontario, and northwestern Ohio. There is then some hope for commercial production.

Problems inherent in the Cambrian, wherever present, are recognized here. Woodward points out that the Cambrian, on outcrop, shows a degree of low-grade metamorphism with consequent loss of porosity and probable outright expulsion of all fluids. Every Paleozoic pulsation affected the Cambrian along with pre-Ordovician and early Ordovician erosion. Westward and basinward from the outcrop, the sediments should be unaltered. In West Virginia, Woodward feels the Upper Cambrian, essentially a dolomite series, is a better reservoir possibility than the middle limestone and shales.[1] The upper dolomite section may be, however, an Ellenburger or Arbuckle equivalent. Since much of the Appalachian production (largely Devonian)

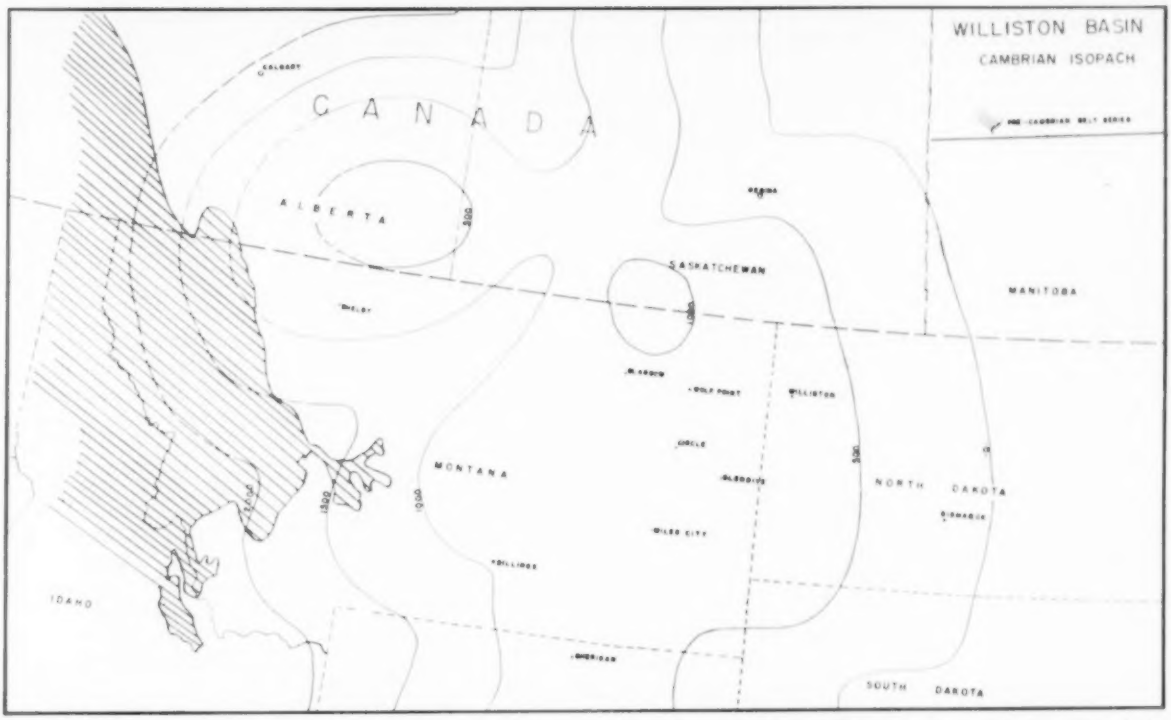


**Fig. 3—Adapted from Fig. 5, G. J. Hamilton, "Orogenic History of the Williston Basin," Billings Geological Society, fourth annual field conference, 1953, and Plate 5-A, Eugene S. Perry, Memoir 35, Oil and Gas in Montana, Montana Bureau of Mines and Geology.**

is more related to stratigraphic conditions than structural, it will probably be some time before pre-Devonian features are seismically mapped and tested. Only then will a true evaluation of Cambrian productive possibilities in this province be realized.

### Eastern Interior Basin

The estimated maximum thickness of Cambrian strata in the Eastern Interior basin of Illinois, Kentucky, and Indiana is on the order of 3,500 ft. (Fig. 2). The sedimentary series has a similarity with the Texas and Appalachian sections; a basal, generally coarse sand, tinted or coated by the oxides of iron; a medial section of alternating carbonates, shales, and sands, usually accompanied by a dispersion of glauconite, and an upper carbonate portion. The maximum thickness of the Cambrian is in the area of greatest oil production. But it is rather surprising that a basin which has produced nearly 1¾ billion barrels of oil has not had a basement test in one of the outstanding fields. Low penetration rate per bit has not been a deterrent to deep drilling in other prolific basins.

To date in Illinois only one producing structure, Waterloo-Dupo, has been drilled to the Cambrian (only 1,800 ft. deep) and a flank test of this same structure reported shows from the Cambrian.[2] Since nearly 75 per cent of total oil has come from Mississippian reservoirs, 20 per cent from Pennsylvanian strata, 4 per cent from Devonian strata, and only 1 per cent from Silurian and Ordovician together,[3] the percentage players in Illinois are probably little interested in Cambrian possibilities, especially so long as some shallow oil continues to be found. Regional features such as the La Salle anticline afford the opportunity to probe for the type of conditions which have yielded Cambrian oil in Kansas.

### Mid-Continent Area

In the Mid-Continent area, Cambrian strata have been penetrated over a wide area. Commercial accumulation of oil in the Cambrian horizons has been restricted, however, to two areas: the Central Kansas uplift and the Eastern platform of the Permian basin of West Texas.

**Kansas . . .** In Kansas, 10 fields have produced 48,000,000 bbl. of oil from the pre-Arbuckle or Reagan sand. Percentagewise, this is a very small portion of the total Kansas production which has come largely from the Arbuckle and Pennsylvanian horizons. Recoveries per acre are indicated to be on the order of 3,000 bbl. Areawise, Reagan production is restricted to western Kansas and in close association with the Central Kansas uplift. Ver Wiebe feels that here all Cambrian production is from stratigraphic accumulations with the sand . . . "in close contact with overlying Pennsylvanian oil-bearing beds. Thus the explanation of the oil occurrence is directly related to juxtaposition of porous rocks with overlying oil-generating beds. In other words, age is incidental. There is one exception to this blanket appraisal. That is Fairport pool in western Russell County. Here a considerable thickness of beds has been found between the basal sand and the oil-bearing Pennsylvanian strata. The probable explanation here is that pronounced anticlinal structure with **faulting** has allowed migration through the beds."[4]

The Cambrian of Kansas is related,


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therefore, structurally and stratigraphically to similar accumulations on the Eastern platform of Texas. A regional basement high (Kansas) and a series of basement highs (Eastern platform) produced arching and truncation of the overlying beds. Some fracturing is probably also associated with draping. Erosion of post-Cambrian beds permitted Cambrian porosity to be in contact with, or close to, younger beds carrying or generating oil. Cambrian sands acted then as thief zones, robbing the stratigraphically higher strata of hydrocarbons. The same effect is accomplished also by faulting with Cambrian pore space thrown up against younger oil-bearing strata, which is the case at Lost Soldier and Wertz Dome in Wyoming.

**Eastern platform of Texas . . .** For the moment, Texas has production from the oldest to the youngest sediments. But 52 years intervened between the discovery at Spindletop and the realization of commercial Cambrian oil at White Flat field in northeastern Nolan County. Slightly more than a half century of drilling and accumulated knowledge was necessary to localize regionally the correct structural and stratigraphic combination which makes Cambrian oil fields. The Eastern platform of Texas had revealed Ellenburger denuded highs prior to this discovery, e.g., Susan Peak field in Tom Green County, but no commercial production. White Flat field was quickly followed by Bronte (Cambrian shutin) and Rawlings (North Bronte) fields of Coke County and the recent discoveries south of White Flat.

This regional trend of localized basement highs, with the Ellenburger missing and the Pennsylvanian lying unconformably on Cambrian, extends from west of Abilene southward through eastern Nolan and Coke counties and thence somewhat southwesterly through Tom Green County to the Humble Oil & Refining Co. 1 Spencer in Schleicher County. The latter well went directly from Pennsylvanian rocks into granite, but on the flanks of this high, Atlantic found both Ellenburger and Cambrian gas, although in rather small volume. The current play on this trend is decidedly bullish with wildcat acreage bringing $50 and up. Reportedly, offset acreage has brought $1,000 and surprisingly high overrides.

### Rocky Mountain Province

Productive basins in the very active Rocky Mountain oil country are generally underlain by a Cambrian section which seldom exceeds a thousand feet in thickness. In contrast, the Cordilleran trough received from 10,000 to 40,000 ft. of Cambrian sediments as reflected in the Rockies of Utah-Idaho[5] area and of Canada.[6]

#### Colorado

**Denver-Julesburg basin . . .** The Denver-Julesburg recently joined the ranks of Paleozoic producing basins with the establishment of production from the Lyons sandstone, not younger than Permian in age. Deeper drilling has failed, however, to reveal the definite presence of Cambrian sediments. Wells that have reached basement have gone from Permian, Pennsylvanian, or Mississippian directly into pre-Cambrian. Age is unassignable to a very thin section of conglomerate between the Paleozoic carbonates and basement. Even if this clastic section is Cambrian, the possibility of such production from this basin appears almost nil.

**Uinta basin . . .** Rangely field contains an outstanding petroleum reserve in the Pennsylvanian Weber sandstone. No basement test has been dug in this large surface feature or in nearby Wilson dome, although currently The Texas Co. is drilling a Madison test at Rangely. The Cambrian may be at prohibitive depths, but vertical migration of oil is indicated by production from the Shinarump shales and hence with faulting, if present at depth, the Cambrian remains an objective. Production in the Utah portion of the basin is restricted to the Tertiary and no tests deeper than the Cretaceous are known.

#### Wyoming

Wyoming perhaps until recently has had the largest single reserve of Cambrian oil in the United States. In June 1948, Sinclair Wyoming Oil Co. completed its 2 Dayton-Consolidated in Lost Soldier field from the Cambrian, topped at 5,472 ft. The well flowed 720 bbl. of oil in 24 hours by gas lift. Cumulative production is around 2 million barrels, the reserve estimated at 11 million barrels for an ultimate total recovery of 13 million barrels. With 900 acres estimated to be productive, the recovery per acre will be in excess of 14,000 bbl.

The Cambrian sequence is described by Potts and DeVore: "The upper zone of the Cambrian is composed of red, arkosic, micaceous and highly glauconitic, fine, tight, calcareous sandstone, with numerous waxy, predominately green, micaceous slaty shales and shale partings and dolomite stringers. The amount of arkose and glauconite decreases below the top 200 ft. of the Cambrian. The lower unit, Flathead, 165 to 220 ft. of effective pay sand, is a medium to coarse-grained, porous, oil-stained sandstone that is conglomeratic at the base."[8]

Both Lost Soldier and Wertz Dome produce from every porous horizon in the stratigraphic column, whether sand or lime, and from nearly grass roots to basement. Geologists in the area point out that Pennsylvanian-Mississippian-Cambrian oil has the same gravity and is the same type of oil. The Jurassic and Cretaceous oil is about 5° less in gravity. Many workers in the area believe that all of the oil may have been furnished by the Cretaceous sands and that faulting associated with these two anticlines provided both the avenues of escape from one zone to the other through vertical migration and/or necessary lift of the older, porous horizons bringing them near to or in contact with the younger oil reservoirs.

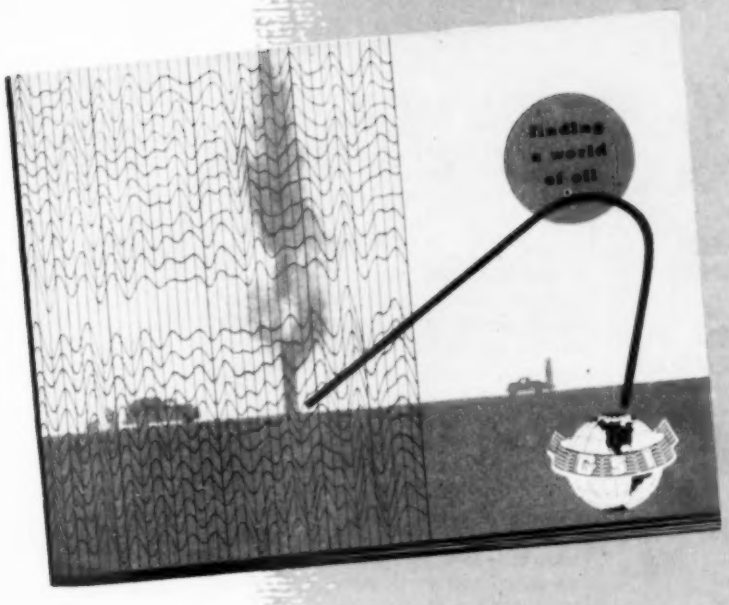
In any event, it appears that the Cambrian production has been derived from post-Cambrian reservoirs. Fracturing and shattering associated with the faulting have also increased the poro-permeability of all productive zones below the Embar. Some 15 other anticlines in Wyoming have been drilled to basement without any shows in the Cambrian. In these tested structures, it is possible that faulting was not of sufficient magnitude or age to transpose potential Cambrian reservoirs into juxtaposition with younger oil-bearing zones. Also the inducement of secondary poro-permeability in the Cambrian strata by shattering or fracturing may be significant.

Several hundred more anticlines in Wyoming remain yet to be tested to the Cambrian. It is therefore altogether possible that additional Cambrian oil will be found wherever the apparently necessary factors of post-Cambrian oil, faulting, fracturing and/or stratigraphic thinning, are present.

#### Williston Basin

An isopach map (Fig. 3) of this new Paleozoic (largely Mississippian), producing basin indicates that Cambrian sediments attain a thickness of about 1,000 ft. The section encountered in wells drilled to date is essentially similar to that at Lost Soldier—a series of sandstones and siltstones, highly glauconitic and with minor amounts of shale. The best porosity is in the basal portion. No Cambrian shows have yet been found, which is not surprising since basement tests have been so few.

The Ordovician has recently been proved productive in this basin; hence, if for no better reason, the stratigraphic proximity of Cambrian indicates that it has a producing chance. No block faulting, in contrast to Lost Soldier, has yet been noted in the fields of the Williston basin, for, in general, the anticlinal features are weak. The areal magnitude, lengthwise, of the

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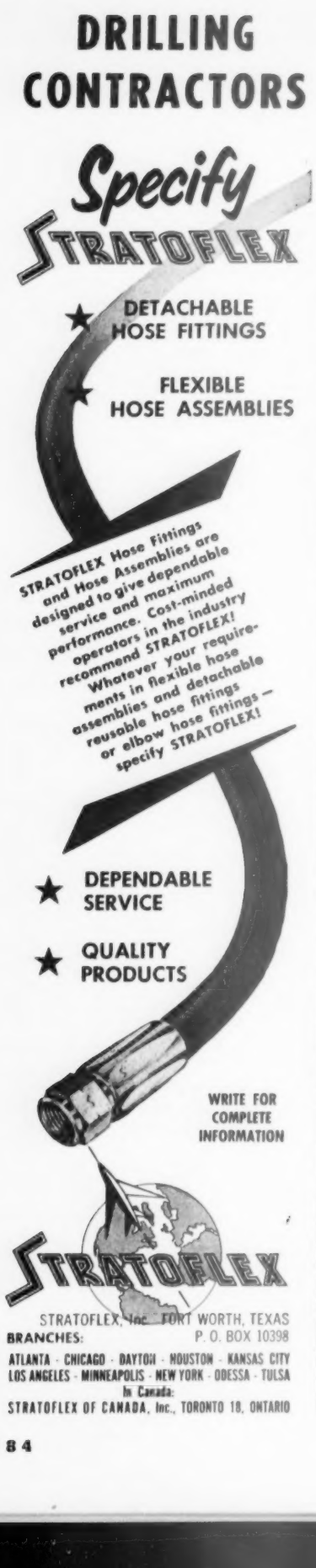
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Cedar Creek and Nesson anticlines, illustrates the possibility of truncation of nonporous Cambrian strata and overlap by Winnipeg shales. Mid-Continent geologists have high regard for the oil-generating ability of these shales which are probably equivalent to the Simpson.

Shell's current test at Cabin Creek, on the Cedar Creek feature, tested noninflammable gas, which nevertheless contained hydrocarbons. This gas from below 10,000 ft. may be from the Cambrian.

### Conclusion

Cambrian oil, found only in the western United States, has been produced since 1932, but the discovery rate increased markedly in 1953. Accumulations of Cambrian oil, to date, have been associated with faulted reservoirs and truncated basement highs with Cambrian porosity overlapped unconformably by younger beds. This porosity is sometimes primary and/or secondary. The Cambrian, considered here then only for its storage capacity, may have lithologic facies which served as an oil factory in some of the deeper Cambrian basins.

Indigenous Cambrian oil may still be unexpelled in those deep negative areas largely unaltered by recurrently dynamic time. The depth range of Cambrian production is: in Kansas from 3,100 to 3,900 ft., Eastern platform 5,400 to 6,100, and Lost Soldier-Wertz Dome 5,400 to 7,500 ft. These depths indicate only that the economics of oil finding have directed the search to date to the shallower areas. With recoveries of Cambrian oil possibly as high as 25,000 bbl. per acre, or a million barrels per 40-acre well site, there is little doubt that when conditions favor, few operators will abandon a test short of basement.

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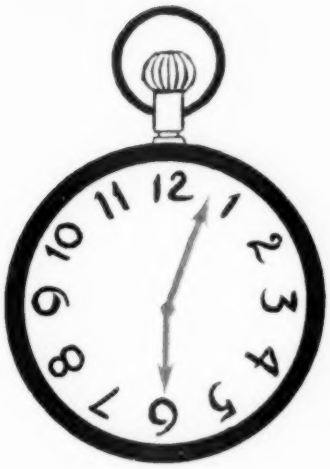

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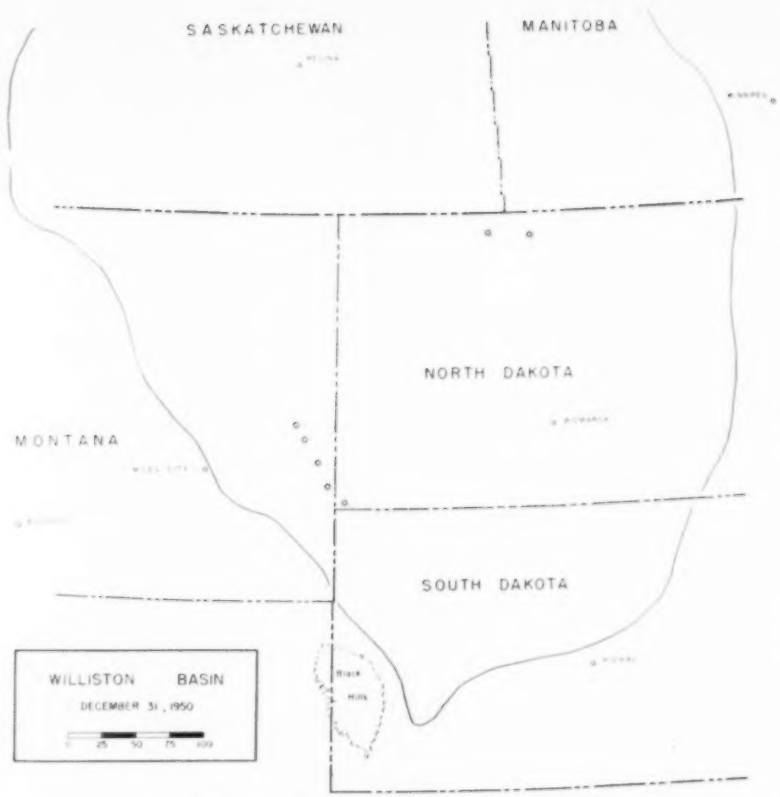


Fig. 1—Williston basin map as of December 31, 1950.

**TABLE 1—WILLISTON BASIN STATISTICS**

1951— 5 pay horizons
1953—19 pay horizons

1951— 3 oil fields
1952—31 oil fields; 2 gas fields; 13 extensions in North Dakota and Montana
1953—54 oil fields; 4 gas fields; 22 extensions in North Dakota and Montana

**UNITED STATES PORTION OF WILLISTON BASIN—1953**

| | Wild-cats | Oil dis-coveries | Gas | Ex-tensions |
|---|---|---|---|---|
| North Dakota | 95 | 8 | 1 | 5 |
| South Dakota | 10 | 1 | | |
| Montana | 59 | 4 | | 4 |
| Total | 164 | 13 | 1 | 9 |

Success ratio—1 out of 7 or 14 per cent.

| | Develop-ment tests | Oil wells |
|---|---|---|
| North Dakota | 177 | 161 |
| South Dakota | 0 | |
| Montana | 96 | 72 |
| Total | 273 | 233 |

Success ratio—17 out of 20 or 85.3 per cent.
Footage drilled 1953—3,328,750 ft.

# The Story of Williston Basin

**by Ray L. Harrison, Jr.**

FIG. 1 pictures the Williston basin as it was at the end of 1950. The outline of the basin, although quite arbitrary, has been made to conform with the majority of published information on the subject and strikes a happy medium between the 125,000 to 250,000 sq. miles at various times assigned to it. No attempt has been made to show the few scattered dry holes that had been drilled by this time.

Notice especially the total absence of producing oil fields in the basin. The gas wells shown along the axis of the Cedar Creek anticline in southeastern Montana and southwestern North Dakota were several hundred in number and were the result of development that started in 1913. This gas, which is still being produced, is primarily from the Judith River and Eagle sandstones of Upper Cretaceous age, found at depths of from 700 to 1,400 ft. The few scattered gas wells in Renville and Bottineau counties in North Central North Dakota produced from the Tertiary or Upper Cretaceous and were all noncommercial. Mention should be made of the fact that oil was first discovered in the Williston basin in 1936 on the Cedar Creek anticline south of Baker, Mont., in the vicinity of the gas wells shown on the map. Here, a total of 25,000 to 30,000 bbl. of oil was produced from three wells before they were all abandoned a few years later.

As is frequently the case in a new oil province, people concerned with the exploration for oil in the Williston basin are inclined to become so absorbed in the present and future that they tend to overlook the significance of their past accomplishments. Here the author deviates from this inclination and views in retrospect the development of this basin from its very beginning to its present state of development. Reasons become self-evident why the Williston basin is destined to maintain its position as one of the leading exploration frontiers on this continent.

### Real Oil in 1951

The basin became a bona fide oil producer in February 1951 (Fig. 2) when California Standard Oil Co. of Canada brought in the discovery well in Virden (or Daly) field in Manitoba. Although not a sensational producer, this discovery was of utmost importance because it proved the accumulation of oil in a part of the basin that was far removed from any previous shows.

**A pint of oil . . .** At about this same time Amerada Petroleum Corp. recovered the now famous "pint of oil" on

drill-stem test of its 1 Iverson in Williams County, North Dakota, the first free oil recovered in that state. This Beaver Lodge discovery was first completed in the Silurian, subsequently plugged back to the Devonian, and finally completed in the Mississippian. Toward the middle of the year, Shell Oil Co. recovered oil from the Mississippian at its Richey field discovery in McCone County, Montana. Several other wells in Montana showed oil during 1951 but none of them was on production at the end of the year.

These three discoveries were important not only because they were oil wells, but also because they proved in each case the coincidence of oil accumulation with a seismograph anomaly; and, in the instance of the Beaver Lodge field, a decided coincidence with a large surface feature.

### The Second Year

The year 1952 was a very successful year. Production was extended into the basin portion of Saskatchewan, and additional shallow discoveries were drilled in Manitoba and also in North Dakota (Fig. 3).

Exploration in the deeper parts of the basin continued at a rapid pace with a considerable number of new pay horizons being added and previous pays extended into new areas.

With very few exceptions, successful wildcat locations were based on seismic work, or on seismic work in conjunction with surface geology.

### Third Year Phenomenal

The year 1953 showed a continuation of the phenomenal discovery rate established the previous year (Fig. 4). In the central part of the basin, Brorson and Fryburg fields were discovered at locations completely removed from any visible evidence of surface structure. Paleozoic sand pays of commercial character, the first in the basin, were drilled in Fryburg field in North Dakota, and South Dakota came in for its first oil production. The greatest thickness of over-all pay in the basin was markedly extended in Shell's Cabin Creek discovery where 800 ft. of total formation containing oil was reported.

One of the most important discoveries of the year started development in Roselea field in Manitoba where excellent flush production of as much as 2,500 bbl. of oil per day has been recovered from the Mississippian at a depth of only 2,100 ft.

Fig. 5 reveals the Williston basin as it was at the end of 1953, just 3 years after the Virden discovery was drilled. Commercial oil or gas is being produced from 15 different pay horizons, while 3 additional zones have made oil showings that may eventually prove producible. The Tertiary-Cretaceous gas in Renville County, North Dakota, has not been explored sufficiently to establish it as a commercial pay. Actually, only formations of Cambrian, Pennsylvanian, Permian, and Triassic age are not being produced, and it is quite probable that the Pennsylvanian will be removed from this category before long.

In establishing this enviable 3 years of progress, the reflection seismograph stands out as the most valuable means of exploration. With the exception of a few fields on the flanks of the basin, all major discoveries were drilled after the area had been shot. In many cases this shooting was supplemented by surface work, or vice versa, and frequently by gravity or magnetometer, but in most instances the shooting was the deciding factor.

This situation is quite understandable because until quite recently there has been insufficient subsurface control to enable geologists to do more than formulate generalized regional ideas. The scarcity of subsurface information becomes quite apparent when it is realized that at the end of 1953 the density of exploratory wells in that portion of North Dakota lying within the confines of the basin as shown in Fig. 5 was approximately one test in every 375 sq. miles.

In certain parts of the basin, however, this control is now becoming more abundant and it will be only a matter of time before subsurface geology as-

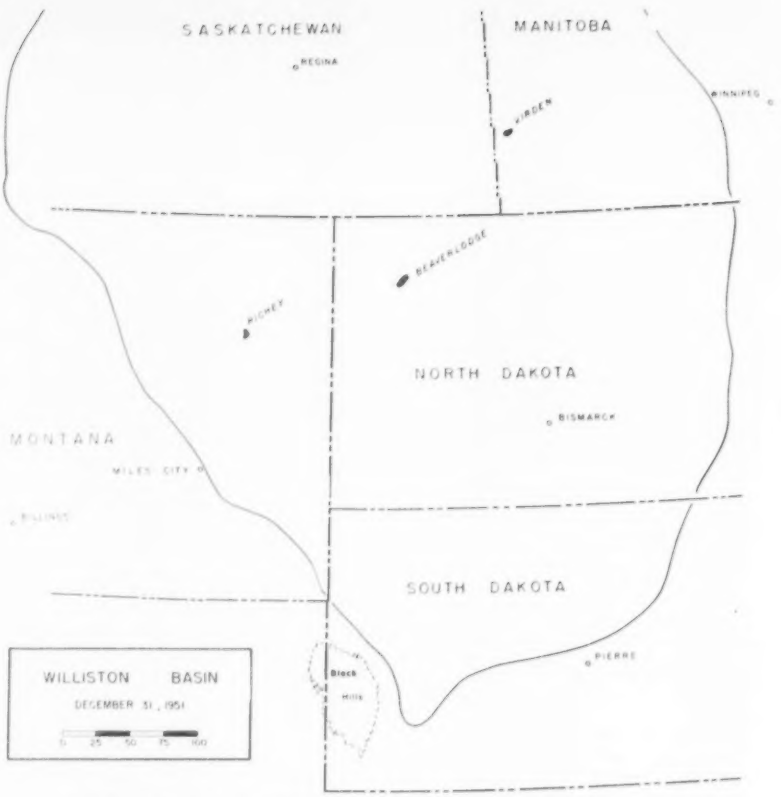


**Fig. 2—Williston basin map showing locations of fields discovered in 1951.**

| Name, location, and producing formation— | Depth |
|---|---|
| Virden, Manitoba, Mississippian (Lodgepole) | 2,450 |
| Beaver Lodge, North Dakota: | |
| Silurian | 11,600 |
| Devonian | 10,500 |
| Mississippian (Mission Canyon) | 8,500 |
| Richey, Montana, Mississippian (Charles) | 7,200 |

Total—3 oil fields


THE AUTHOR

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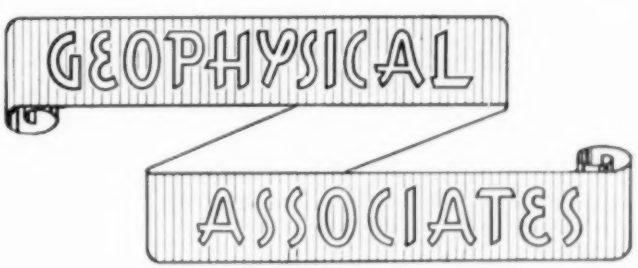


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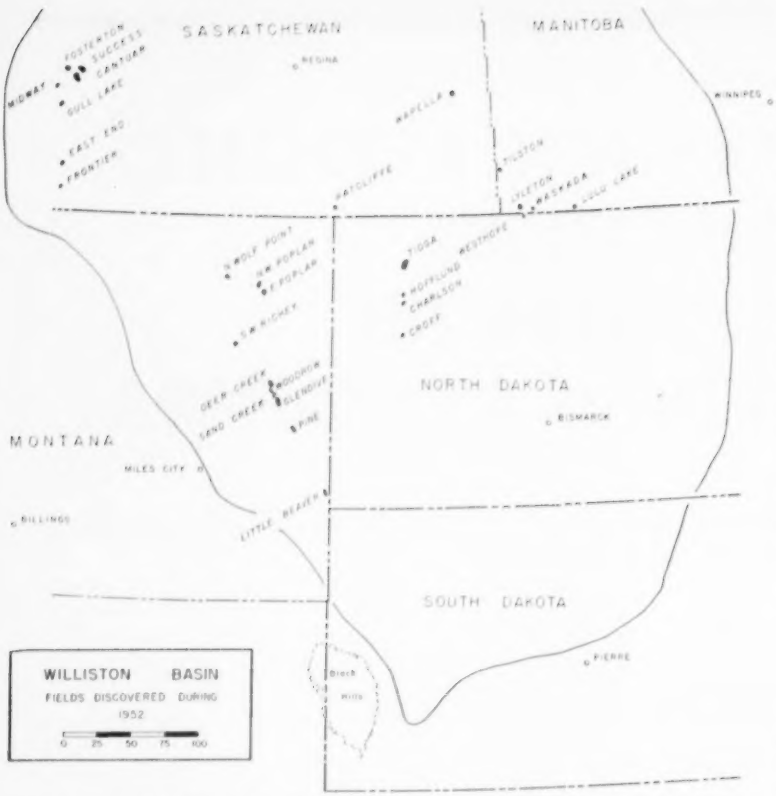


**Fig. 3—Williston basin map showing locations of fields discovered in 1952.**

| Name, location, and producing formation— | Depth |
|---|---|
| Tilston, Manitoba, Mississippian (Lodgepole?) | 3,100 |
| Waskada, Manitoba, Mississippian (Mission Canyon) | 3,025 |
| Lyleton, Manitoba, Mississippian (Mission Canyon) | 3,200 |
| Lulu Lake, Manitoba, Mississippian (Lodgepole) | 3,300 |
| Croff, North Dakota, Mississippian (Mission Canyon) | 9,500 |
| Tioga, North Dakota, Mississippian (Mission Canyon) | 8,200 |
| Charlson, North Dakota, Mississippian (Mission Canyon) | 9,000 |
| Hofflund, North Dakota, Mississippian (Mission Canyon) | 8,675 |
| Westhope, North Dakota, Mississippian (Charles) | 3,350 |
| Glendive, Montana, Ordovician (Gunton and Red River) | 9,050 |
| Pine, Montana, Ordovician (Gunton and Red River) | 8,950 |
| East Poplar, Montana, Mississippian (Charles) | 5,700 |
| Northwest Poplar, Montana, Mississippian (Charles) | 6,175 |
| Deer Creek, Montana, Ordovician (Red River) | 9,900 |
| Little Beaver, Montana, Ordovician (Red River) | 8,500 |
| Woodrow, Montana, Mississippian | 7,850 |
| Sand Creek, Montana, Silurian | 9,000 |
| Southwest Richey, Montana, Devonian, Silurian, Ordovician | 9,100 |
| North Wolfpoint, Montana, Mississippian (Mission Canyon) | 6,400 |
| Fosterton, Saskatchewan, Lower Cretaceous-Jurassic (Roseray sand) | 3,100 |
| Midway, Saskatchewan, Jurassic (sand) | 3,450 |
| Midway Gas, Saskatchewan, Jurassic (Lower Shaunavon sand) | 3,450 |
| Cantaur, Saskatchewan, Lower Cretaceous-Jurassic (Cantaur and Roseray) | 3,100 |
| Success, Saskatchewan, Lower Cretaceous-Jurassic (Roseray sand) | 3,200 |
| Eastend, Saskatchewan, Jurassic (limestone) | 4,700 |
| Wapella, Saskatchewan, Lower Cretaceous (Wapella sand) | 2,300 |
| Ratcliffe, Saskatchewan, Mississippian (Mission Canyon) | 6,350 |
| Frontier, Saskatchewan, Jurassic (limestone and sand) | 4,500 |
| Gull Lake, Saskatchewan, Jurassic (limestone and sand) | 4,000 |
| Gull Lake Gas, Saskatchewan, Jurassic (Vanguard sand) | 3,200 |

28 oil, 2 gas, and 13 extensions in Montana and Notrh Dakota

sumes its proper place as an important oil-finding tool. Meanwhile, until more holes are drilled, it can be expected that seismic work will account for the majority of new discoveries in the deeper parts of the basin, while subsurface geology will become increasingly important in the finding of stratigraphic oil accumulations along the basin flanks.

### Comparative Success Ratios

Table 1 presents a summary of the previous maps and tabulations. In total, the basin at the end of 1953 contained 54 oil fields, 4 gas fields, and 22 field extensions (many of the latter being several miles from the nearest production). The lower half of Table 1 shows the 1953 success ratios of exploratory and development wells within the United States portion of the basin. This restricted part of the basin was used so that a comparison could be made with other producing states in this country.

Considering the lack of subsurface control, the United States Williston basin success ratio of one out of seven, or 14 per cent for wildcats in 1953 is quite good (Table 2). This percentage is only 3½ per cent below the national average and considerably higher than the ratio in many established oil states.

As for development well success, Table 2, the basin had an enviable record in 1953. The success ratio of 17 out of 20, or 85.3 per cent for field wells was exceeded only by the states of California and New Mexico, and was 13 per cent better than the national average.

### Production

The production figures in Table 3 have been prepared to clarify any false impression that may have been inferred from this discussion so far. The production of oil in the Williston basin, even though approaching the 10-million-barrel mark for 1953, is not what one would expect from more than 50 fields.

There are two basic reasons for this. First of all, most of the fields are as yet in their infancy, and many consist of only one or two wells. Occasionally the discovery wells are only marginal or submarginal producers and in these cases development has been especially slow. With emphasis still on exploration, development drilling comes in for a smaller share of the over-all budget than in older oil-producing areas. It can be safely said that no field in the basin has even approached having its limits defined by development drilling.

The second, and most important, reason for this limited production is the absence of a ready market for the crude. This is reflected in North Dakota's present production of only 425,000 to 450,000 bbl. per month when a tentative MER of 2,047,500 bbl. per month has been set by the North Dakota State Geological Survey. This same situation definitely applies to Montana and Saskatchewan, and to a lesser degree to Manitoba.

### Reserves

To attempt at this time a detailed evaluation of the proved or semiproved reserves in all pay horizons in the entire Williston basin would be pure fantasy. Much of the information required for such a project is not avail-

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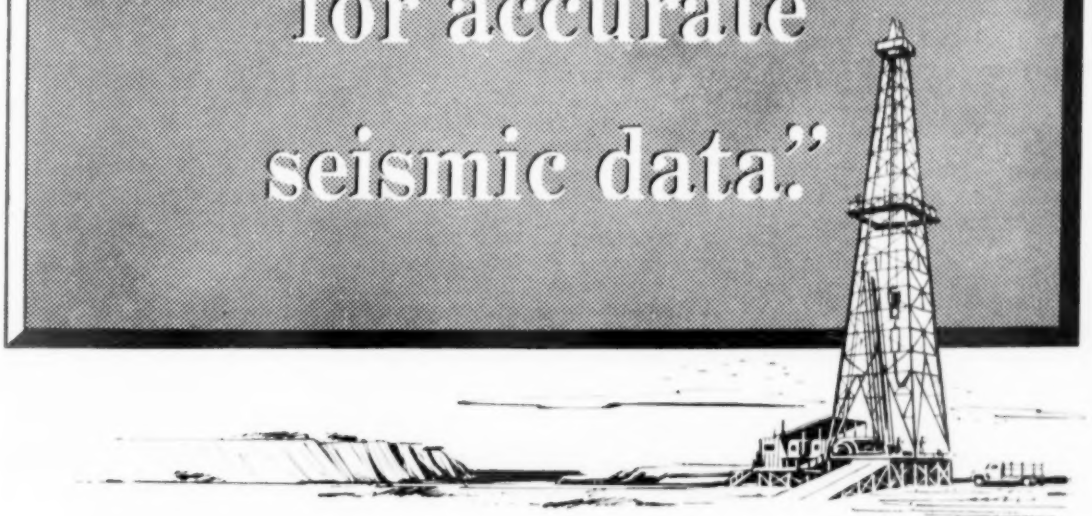

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**TABLE 2—UNITED STATES EXPLORATION RESULTS—1953**

| | Total wildcats | Per cent successful oil and gas wells |
|---|---|---|
| Louisiana | 513 | 28.1 |
| New Mexico | 168 | 25.6 |
| Oklahoma | 742 | 21.2 |
| Texas | 5,245 | 20.4 |
| Wyoming | 189 | 16.7 |
| California | 666 | 15.2 |
| Kansas | 887 | 14.9 |
| **U. S. Williston basin** | **164** | **14.0** |
| Mississippi | 207 | 13.5 |
| Colorado | 364 | 11.5 |
| Michigan | 279 | 9.6 |
| Kentucky | 213 | 9.3 |
| Indiana | 373 | 6.5 |
| Illinois | 425 | 3.7 |

National average—1953 = 17.5 per cent.

All except Williston basin figures taken from The Oil and Gas Journal January 25, 1954.

**DEVELOPMENT COMPLETIONS—1953**

| | Comp. | Oil | Gas | Per cent successful |
|---|---|---|---|---|
| California | 1,912 | 1,786 | 29 | 95 |
| New Mexico | 1,250 | 547 | 585 | 91 |
| **U. S. Williston basin** | **273** | **233** | **0** | **85.3** |
| Wyoming | 728 | 594 | 22 | 84.6 |
| W. Virginia | 595 | 70 | 407 | 80 |
| Texas | 11,758 | 8,476 | 809 | 79 |
| Colorado | 370 | 228 | 51 | 75 |
| Louisiana | 2,315 | 1,475 | 201 | 72 |
| Nebraska | 159 | 104 | 7 | 70 |
| Oklahoma | 6,851 | 4,475 | 302 | 70 |
| Michigan | 344 | 223 | 13 | 69 |
| Utah | 28 | 14 | 5 | 68 |
| Kansas | 3,896 | 2,113 | 343 | 63 |
| Mississippi | 190 | 111 | 7 | 62 |
| Arkansas | 433 | 261 | 1 | 61 |
| Illinois | 1,740 | 1,054 | 4 | 61 |
| Kentucky | 951 | 383 | 190 | 60 |
| Ohio | 1,058 | 467 | 170 | 60 |
| Pennsylvania | 1,487 | 629 | 250 | 59 |
| Alabama | 28 | 16 | 0 | 58 |
| New York | 696 | 355 | 0 | 51 |
| Indiana | 907 | 430 | 20 | 50 |

National average—1953 = 72 per cent.

All figures except for Williston basin taken from The Oil and Gas Journal, January 25, 1954.

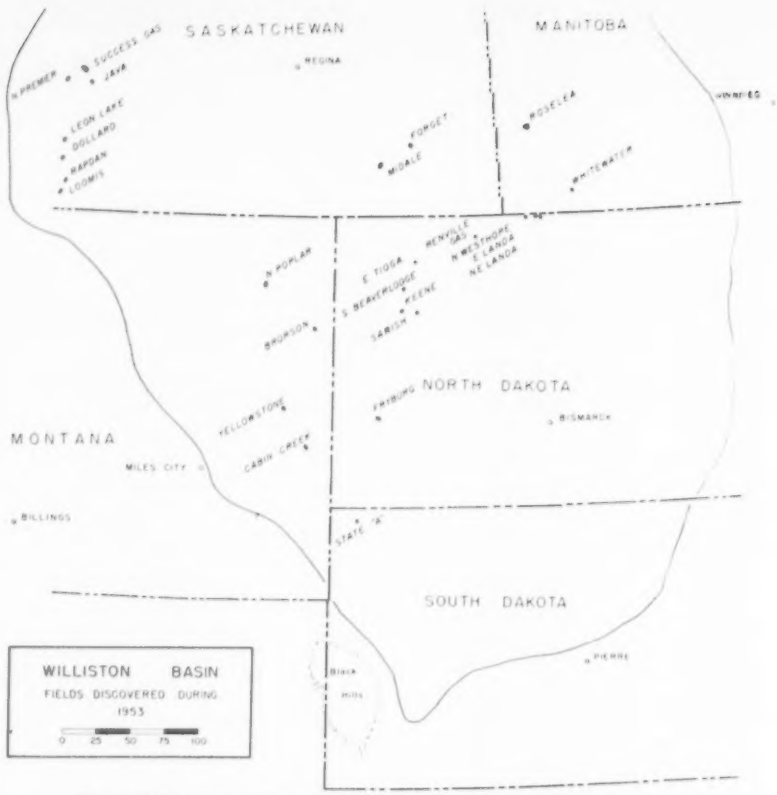


**Fig. 4—Williston basin map showing locations of fields discovered in 1953.**

| Name, location, and producing formation— | Depth |
|---|---|
| Roselea, Manitoba, Mississippian (Lodgepole) | 2,100 |
| Whitewater, Manitoba, Mississippian (Lodgepole) | 2,500 |
| Keene, North Dakota, Mississippian (Mission Canyon) | 9,100 |
| Northeast Landa, North Dakota, Mississippian (Mission Canyon) | 3,075 |
| East Landa, North Dakota, Mississippian (Mission Canyon) | 3,075 |
| North Westhope, North Dakota, Mississippian (Charles) | 3,250 |
| Fryburg, North Dakota, Mississippian (Mission Canyon) | 9,400 |
| East Tioga, North Dakota, Mississippian (Mission Canyon) | 8,375 |
| South Beaver Lodge, North Dakota, Mississippian (Mission Canyon) | 8,325 |
| Sanish, North Dakota, Devonian (Three Forks-Sanish sandstone?) | 10,525 |
| Renville Gas, North Dakota, Cretaceous (sand and shale) | 300 |
| "State A," South Dakota, Ordovician (Red River) | 8,700 |
| Cabin Creek, Montana: | |
| Ordovician (Gunton and Red River) | 7,000 |
| Mississippian and Silurian | to 9,000 |
| North Poplar, Montana, Mississippian (Charles) | 5,750 |
| Brorson, Montana, Ordovician (Red River) | 12,600 |
| Yellowstone, Montana, Ordovician (Red River) | 8,775 |
| Success Gas, Saskatchewan, Lower Cretaceous (Roseray sand) | 3,075 |
| North Premier, Saskatchewan, Lower Cretaceous (Roseray sand) | 3,400 |
| Forget, Saskatchewan, Mississippian (Mission Canyon) | 4,000 |
| Java, Saskatchewan, Lower Cretaceous-Jurassic sands | 3,300 |
| Rapdan, Saskatchewan, Jurassic calcareous sands | 4,600 |
| Loomis, Saskatchewan, Jurassic limestone | 4,575 |
| Leon Lake, Saskatchewan, Jurassic sands | 4,000 |
| Dollard, Saskatchewan, Jurassic sands | 4,600 |
| Midale, Saskatchewan, Mississippian (Charles?) | 4,600 |

23 oil, 2 gas, and 9 extensions in Montana and North Dakota

able; were it available one would find that except in a few cases there is not sufficient of it to arrive at a reliable figure. Most of the major operators are reserving their opinions until more engineering data are accumulated. It is exceedingly difficult under the most favorable of conditions to establish the reserves of a field from data obtained from only one or two wells. This task becomes extremely hazardous in an undefined multiple-pay area, where most of the pay consists of fractured limestones and dolomites that show great variations in porosity and permeability.

Using the work of Mack H. Cox as a starting point and applying information obtained from various sources in Saskatchewan, Manitoba, and North Dakota, it is the writer's opinion that a figure somewhere between 500 million and 1 billion barrels of recoverable oil can conservatively be applied to the reserves thus far discovered in the basin.

### Prospects for the Future

At no time in the history of oil exploration in the United States has an oil province as great as the Williston basin remained long without a good market for its crude. History is now beginning to repeat itself in this respect as far as the basin is concerned.

**New plants . . .** Three new refineries with a total capacity of 33,500 bbl. per day will be in operation in North Dakota before the end of 1954. These refineries are being constructed at Man-

**Fig. 5—Map of Williston basin outlining all fields discovered during 1951-1953.**

**1951**

Mississippian (Charles)
Mississippian (Mission Canyon)
Mississippian (Lodgepole)
Devonian (carbonates)
Silurian (carbonates)

**1953**

Upper Cretaceous-Tertiary (sand and shale)
Lower Cretaceous (Wapella sandstone)
Lower Cretaceous-Jurassic (Roseray ss.)
Lower Cretaceous-Jurassic (Cantaur ss.)
Jurassic (Lower Shaunavon sandstone)
Jurassic (Vanguard sandstone)

**1953**

Jurassic (miscellaneous sands)
Jurassic (miscellaneous limestones)
*Triassic (Spearfish? sandstone)
*Pennsylvanian or Mississippian (sandstone)
*Mississippian (Heath) (sandstone)
Mississippian (Charles) (limestone and dolo.)
Mississippian (Mission Canyon) (limestone)
Mississippian (Lodgepole) (limestone)
Devonian (Three Forks?) Sanish (sandstone)
Devonian (carbonates)
Silurian (dolomites)
Ordovician (Gunton) (sandy dolo. and ls.)
Ordovician (Red River) (dolo. and ls.)

*Denotes good oil shows but no commercial production as yet.

dan, Dickinson, and Williston, N. D. Great Northern Oil Co. is scheduled to begin construction of a 25,000-bbl. plant, designed to process heavy Saskatchewan crude, at a location just south of St. Paul, Minn. Northwestern Refining Co., of St. Paul, is adding several thousand daily barrels to its present capacity. Imperial Oil and British American are adding facilities to some of their Saskatchewan installations so that more heavy crude can be processed. Signal Oil & Gas Co. will soon have its 50-million-cubic-foot natural-gasoline plant in operation at Tioga, N. D. North Dakota Natural Gas Transmission Co., of St. Paul, has contracted to buy dry gas from Amerada for delivery to northern and eastern North Dakota.

**Pipelines . . .** The completion of the 300,000-bbl. per day Trans Mountain pipeline from Edmonton, Alta., to Vancouver, B. C., together with completion of the Interprovincial pipeline of similar capacity connecting Edmonton with Sarnia, Ont., is certain to benefit in many ways the Williston basin situation. Service Pipe Line Co.'s 100,000-bbl. per day common carrier from the Beaver Lodge-Tioga area to Mandan, N. D., is also completed and ready for use.

All these facilities will have a marked effect on basin oil marketing. Nothing, however, could quite equal a large common-carrier pipeline running through the basin and connecting with areas to the east where there is existing refining capacity capable of processing large quantities of crude. It is gratifying to know that 12 companies have contracted with Shell Pipe Line Corp. to conduct an economic survey to determine the feasibility and cost of such a project.

**TABLE 3—WILLISTON BASIN PRODUCTION**

**1952 (Cumulative)**

| | Barrels |
|---|---|
| North Dakota | 1,420,000 |
| Montana | 780,000 |
| Manitoba | 120,000 |
| Saskatchewan | (?) |

**1953**

| | |
|---|---|
| North Dakota | 5,265,000 |
| Montana | 2,705,000 |
| Manitoba | 656,000 |
| Saskatchewan (11 months) | 403,000 |

**Monthly Production Estimated Average**

| | |
|---|---|
| North Dakota | *445,000 |
| Montana | 310,000 |
| Manitoba | 110,000 |
| Saskatchewan | Extremely variable |

*North Dakota Geological Survey has set tentative MER for state at 68,250 bbl. of oil per day. 68,250 × 30 = 2,047,500 bbl. oil per month.


## Acknowledgment

Acknowledgment is gratefully made for the assistance rendered by Lion Oil Co.'s scouting and drafting personnel in the Bismarck and Billings, Mont., districts, and to the many persons in the oil industry, too numerous to mention by name, who in one way or another contributed to the preparation of this discussion.


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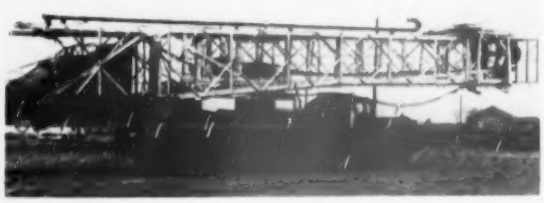

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# Design Factors

*(Continued from page 146)*

number of geophones in a linear array is necessary to accomplish this purpose.

In applying this system to the more difficult areas wherein the surface energy seems to approach from the side as well as in-line, a system which offers minimum response in all directions must be used. From the standpoint of economics, consideration should be given to a system which affords optimum results for a minimum number of units.

Theoretically, maximum response occurs when the wave is symmetric about a linear array of equally spaced units. As each unit at the center of this array has unity response, "lumping" or concentration of units at the center should be avoided.

### Minimizing "Lumping" Effect

An array, consisting of an odd number of legs with equal angular spacing, minimizes this "lumping" effect, and, at the same time offers good discrimination against a broad band of wave lengths. The number of units in each leg is equal to one less than half the number of legs. In other words, if seven legs are used there are three units in each leg. The units are equally spaced from the center in a symmetric fashion as illustrated in Fig. 4.

To a wave approaching one of these legs at right angles, the system breaks into a projection of three linear arrays each containing seven equally spaced units. It will be noted that "lumping" is avoided since there are no excess units.

The response of a 7-3 array with a diameter of 360 ft. is shown in Fig. 5. It is interesting to note that this pattern has less than a 10 per cent response to wave lengths in the range between 310 ft. and 67 ft., thus serving as a band elimination filter.

The undesirable effect of "lumping" is illustrated in Figs. 6 and 7 for an array composed of 48 units arranged in an 8-6 pattern. A comparison shows the average response to continuous surface waves is much greater than that of the 7-3 design (Fig. 4) even though more than twice as many units are in the 8-6 array.

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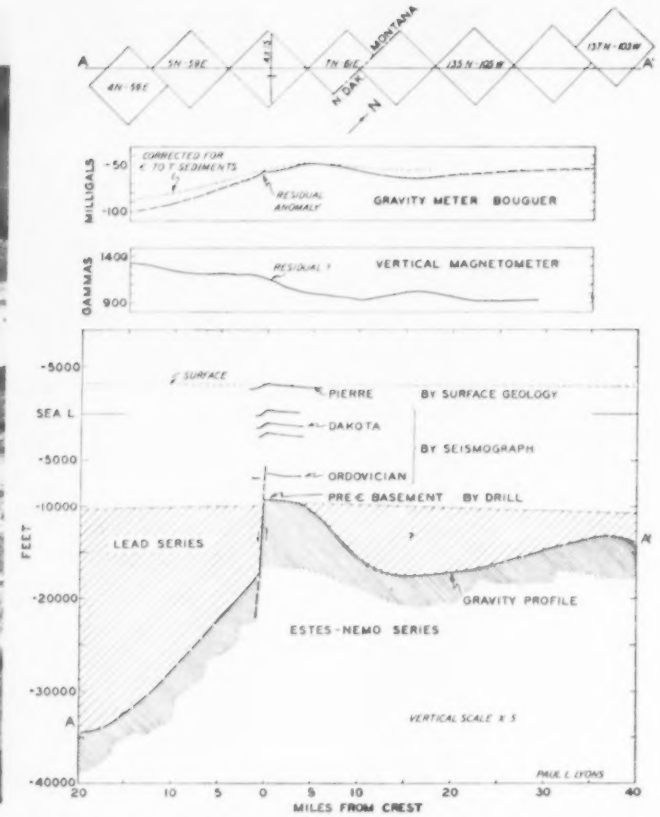
ROAD INACCESSIBILITY, especially in the spring-thaw periods, cuts seismic profile production 40 per cent under summer production levels.




BASEMENT FAULT BLOCKS originating in Black Hills extend under Baker-Glendive anticline. Other fault spurs in basement complex originated from Canadian shield. Fig. 1.

# Seismic Problems in Williston Basin

## Thick Tertiary cover, bad lands, and Quaternary glacial mantle complicate seismic corrections, shot-hole drilling, and equipment mobility in this region.

**by Joseph A. Kornfeld**

THICK Tertiary cover over a major Paleozoic and Mesozoic depression in the Williston basin coupled with badland topography and Quaternary glacial mantle lie at the heart of seismic problems encountered in this portion of the Northern Great Plains province. These factors complicate seismic corrections, shot-hole drilling and equipment mobility in this area. Winter effects reduce seismic production about one-fifth.

### Structural Geology

The Williston basin is a portion of the broad physiographic province known as the Northern Great Plains province.

Author is consulting geologist - engineer, Tulsa.

Area embraced by the Williston basin is about 120,000 sq. miles. The major portion of this area, lying in the United States, totals 80,000 sq. miles.

In the United States, the Williston basin covers portions of North Dakota, South Dakota, and eastern Montana. The basin extends northwards in the western Canadian provinces of Saskatchewan and Manitoba, and is part of a greater basin which extends northward to the Arctic Sea.

**Boundaries . . .** On the northeast, the Williston basin is bounded by the pre-Cambrian Canadian shield in Saskatchewan and Manitoba and the shield's extension into Minnesota. Granites in the Sioux uplift area of southeastern South Dakota bound the basin on the southeast. Northwestward, the basin merges into the Moose Jaw syncline. Tectonic features which separate the Williston basin from the Rocky Mountains are the massive Black Hills uplift on the southwest, and the Central Montana features such as the Sweetgrass arch, and the Bowdoin and Porcupine domes.

**Regional folds . . .** Principal regional folds which have been recognized by surface and subsurface data are as follows:

1. Nesson anticline of northwestern North Dakota on which the cluster of oil fields around the Beaver Lodge-Tioga area is situated.
2. Cedar Creek (Baker - Glendive) anticline of eastern Montana which produces from a series of en echelon deep-seated faulted structures.
3. Poplar anticline, a southeastward-

**TERITIARY COVER affects record quality in seismic work in the Williston basin, especially where a mantle of Tertiary Eocene Fort Union rocks is present.**

**MULTIPLE SEISMOMETERS is one approach to improvement of record quality in Cedar Creek anticline area.**

plunging anticline of northeastern Montana.

Pye[1] traces the earliest definite period of strong deformation in the Williston basin to the pre-Cambrian. Pre-Cambrian trend directions in the eastern portion of the basin are roughly east and west and may be considered spurs off of the Canadian shield. These old structural remnants may be related to the late pre-Cambrian tectonic forces which produced the east-trending structures in the Lake Superior region.

In the southeastern part of the basin, northwest and southeast spurs of the pre-Cambrian highs strike off of the major east and west trends; in Canada, the spurs may trend somewhat southwest. In the Canadian area the spur development seems to be less pronounced than to the south, and directions are not as definite. Some of these spurs may be pre-Cambrian erosion highs, but they have influenced subsequent Paleozoic structure. A probable late Devonian-pre-Mississippian deformation is postulated.

Most significant deformation insofar as basin structure is concerned is the post-Mississippian - pre - Triassic event. This deformation was related to and part of the Appalachian revolution. Pre-existing directions of weakness influenced direction of folding.

Anticlinal folding on the Cedar Creek and the Nesson features antedated the Appalachian deformation and were probably pre - Mississippian - late - Devonian, possibly Ordovician or older.

Direction of plunge is reversed in the post-Mississippian beds owing to change in thickness of the later deposits. A reflection of previous trends is also reflected in the post-mid-Cretaceous period of warping.

Deformation of Tertiary beds in the form of folds and considerable faulting completed development of local tectonic elements of the basin. Although many Tertiary faults can be measured in only tens of feet, they may extend to considerable depths and may be related to deep-seated faults. However, many faults appear to be confined to shallow beds.

### Canadian Provinces

**Southern Saskatchewan . . .** This portion of the Williston basin is underlain by gently dipping sediments ranging in age from Cambrian to Paleocene; all pe-

## Exploration in the Williston Basin . . .

**Geological factors: Subsurface . . .** High - displacement faulting in the basement rocks is expressed on Lower Paleozoic rocks which affect many principal oil-producing reservoirs. Structural remnants related to pre-Cambrian tectonic forces produced spurs off of the Canadian shield in the Williston basin. Post-Mississippian pre-Triassic deformation is significant in geologic history of Williston basin.

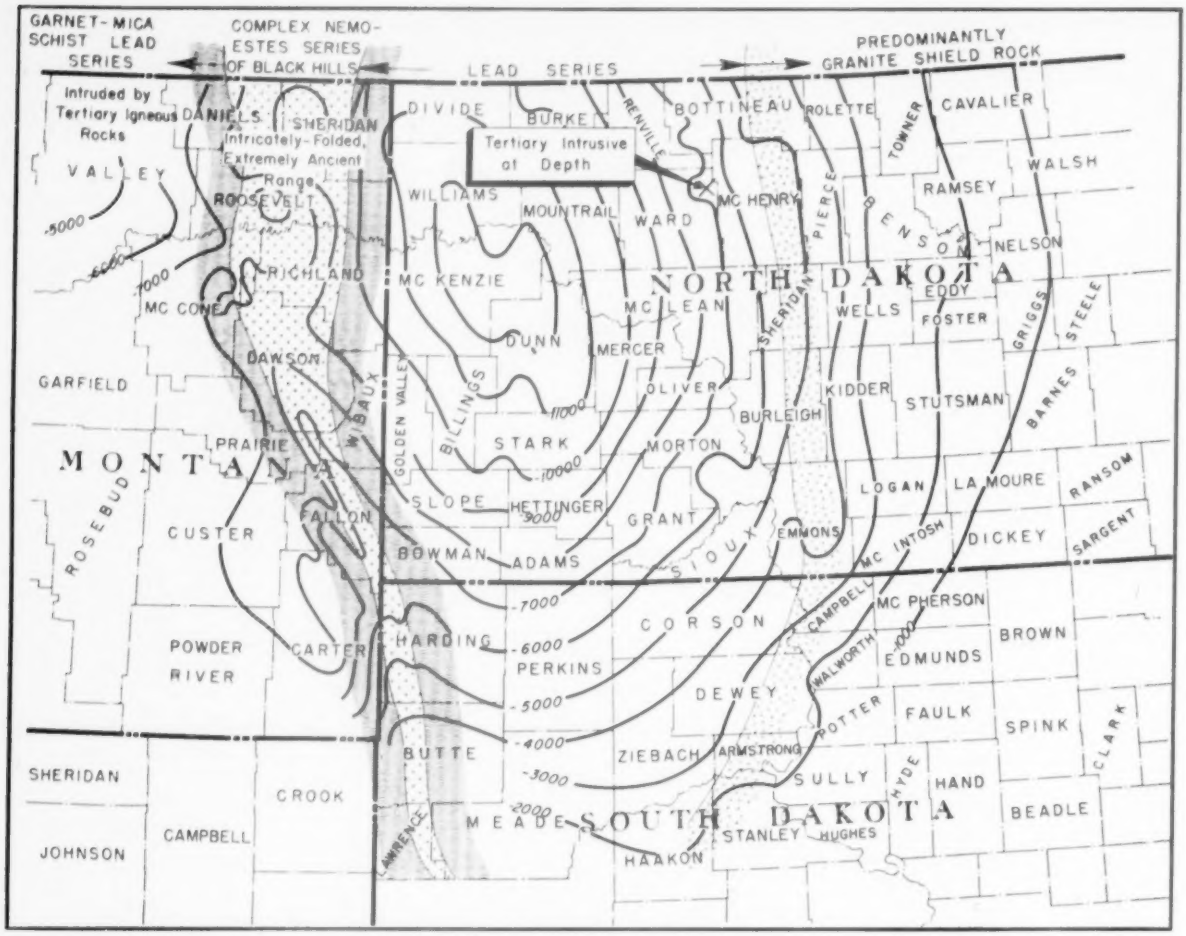
**Geological factors: Surface . . .** Thick Tertiary cover coupled with glacial Quaternary drift with bad-land topography introduced problems in near-surface corrections, shot - hole drilling and equipment mobility. Contrasting variations in lithology of Tertiary rocks cause significant variations in vertical velocities principally where porous layers of sandstone stringers and coal beds outcrop in bad - land topography and in deep coulees.

**Record quality . . .** Record quality is generally good in the Cedar Creek anticline, Plains provinces portion, eastern limb area and Nesson anticline.

**Seismic corrections . . .** Variations in near-surface velocities principal seismic problem on Cedar Creek anticline. Surface corrections supplied generally are uphole-times checked by refractions.

**Field problems . . .** In places presence of thick section of Tertiary cover makes necessary drilling of deep holes. In glacial-drift areas and in hilly areas such as in the Canadian provinces portion of the Williston basin hole-depth requirements range up to 500 ft.

**Winter effects . . .** During winter period, seismic profile production is curtailed to about 80 per cent of summer production due to limited amount of available main roads in the region. In the spring-thaw period seismic profile production drops 40 per cent from normal summer seismic production.




**SUBSURFACE-STRUCTURE** contour map of Williston basin mapped on top of basement complex using mean sea-level datum plane. **Fig. 2.**

riods are represented except the Pennsylvanian and the Permian. In general these sediments dip into the Williston basin.

Types of local structure encountered during the oil-exploration program vary somewhat from those encountered in Alberta. These anomalies have been classified by Bishop[2] into four groups:

1. True tectonic uplifts involving all of the sedimentary section.

2. Anomalies involving Devonian and younger sediments which are believed to have been caused by leaching of the Devonian salt section and subsidence of overlying formations.

3. Anomalies caused by buried Paleozoic topography, some of which do not affect the attitude of the overlying sediments, and others of which show draping over buried Paleozoic hills.

4. Structures involving the younger formations overlying undisturbed older sediments.

**Basement fault blocks . . .** Lyons[3] cites the magnitude and reality of tremendous basement fault blocks in the Williston basin. One of the major fault blocks is shown in Fig. 1 which shows a northeast-southwest geologic cross-section of the Baker-Glendive anticline with interpretation from gravity meter, vertical magnetometer, seismograph, surface geology, and by drill. The subareal extent of the fault blocks delineating the Baker-Glendive anticline is indicated by shaded area in Fig. 2 which is contoured on top of the basement complex (datum: sea level). Other expressions of major structural disturbances in the pre-Cambrian basement complex are reflected in variations of the regional contours of the basement surface shown in Fig. 2.

### Near-Surface Formation Velocities

The most serious conditions affecting reliability of seismic reflection work in the Williston basin are the variations of the vertical velocities in the near-surface formations.

**Glacial drift . . .** In many cases, record quality is adversely affected by the presence of widespread glacial drift which covers most of the surface of the Williston basin to depths as great as 500 ft. in some areas. This is characterized by large piles of boulders seen on the edge

**TABLE 1—PRESENT STATUS OF CONTINUOUS PROFILING EXPLORATION AMONG REPORTING SEISMIC CONTRACTORS IN WILLISTON BASIN**

| Contractor | First year work done in basin | Total crew-months work in 1953 | Percentage distribution of seismic activity | |
|---|---|---|---|---|
| | | | Continuous profiling | Correlation shooting |
| A | 1935 | 35 | 100 | 0 |
| B | 1948 | 47 | 100 | 0 |
| C | 1951 | 35 | 80 | 20 |
| D | 1951 | 12 | 95 | 5 |

# TABLE 2—TABULATION OF WELLS SHOT FOR VELOCITY IN THE WILLISTON BASIN

## NORTH DAKOTA

| County—company, lease and description— | Depth surveyed | Shot by | Date | Sponsor |
|---|---|---|---|---|
| Billings—Amerada 1 Herman May, C NW NE 9-139n-100w | 13,315 | G.R.C. | 1953 | Amerada |
| Bottineau—Hunt 1 Olson, C SW NW 18-163n-77w | 6,410 | Petty | 1952 | |
| Bottineau—California Co. 1 Thompson, SW SW SE 31-160n-81w | 8,246 | N.G.C. | 1952 | |
| Burleigh—Continental-Pure 1 Davidson, SW SW SW 6-140n-77w | 6,950 | Continental | 1949 | Continental-Pure |
| Divide—Argyle Roy. Co. 1 Baukol-Noonan, C SW NE 6-162n-95w | 6,900 | S.S.G. | 1953 | Amerada |
| Grant—Youngblood & Youngblood 1 Kelstrom, SW SW 26-133n-83w | 6,750 | Petty | 1953 | Shell |
| Kidder—Magnolia 1 State, SE NE 36-141n-73w | 5,608 | Petty | 1950 | OKWSA |
| McHenry—Hunt 1 Lenpertz, C NW SE 17-153n-77w | 7,211 | N.G.C. | 1952 | |
| McHenry—Hunt 1 Shoemaker, C NE SW 3-157n-78w | 7,200 | Petty | 1952 | Shell |
| McKenzie—Amerada 1 Risser, C SW SE 12-149n-96w | 10,900 | Amerada | 1952 | Amerada |
| McKenzie—Stanolind 1 Woodrow Star, SW SE 21-152n-94w | 12,404 | Stanolind | 1953 | Stanolind |
| McLean—Stanolind 1 McLean, C SW SW 28-150n-80w | 7,804 | Stanolind | 1952 | Stanolind |
| Mercer—Plymouth 1 Leutz, C NW NE 28-142n-89w | 12,398 | Shell | 1950 | Shell |
| Mountrail—Amerada 1 C. Rice, NE NW 23-158n-94w | 8,614 | Stanolind | 1953 | Stanolind |
| Oliver—Carter 1 Semling, C SE SE 18-141n-81w | 8,310 | Texas Co. | 1942 | OKWSA |
| Rolette—Lion Oil 1 Sebelius, C SE NW 23-161n-73w | 5,500 | Petty | 1952 | Lion Oil |
| Slope—Stanolind-Deep Rock 1 Brusich, 8-135n-98w | 11,522 | Western | 1952 | Stanolind |
| Stutsman—General Atlas-Carbon 1 Peplinski, 21-142n-63w | 2,915 | National | 1952 | Atlantic Ref. |
| Stutsman—Barnett Drlg. Co. 1 Gaier Bros., NW NW 11-141n-67w | 4,133 | U.G.C. | 1951 | Union |
| Towner—Union Oil 1 Saari, 35-161n-68w | 4,495 | National | 1952 | Union |
| Ward—Price Drlg. Co. 1 Kline, SE SE SE 16-157n-85w | 6,506 | Petty | 1949 | OKWSA |
| Williams—California Co. 1 Kamp, C NW NE 3-154n-96w | 9,975 | G.S.I. | 1938 | California |
| Williams—Amerada 1 Bakken, SW SW 12-157n-95w | 11,250 | Amerada | 1952 | Amerada |

## SOUTH DAKOTA

| | | | | |
|---|---|---|---|---|
| Butte—Wm. Seyler Co., Inc. 1 Anderson, 12-18n-5e | 5,756 | N.G.C. | 1949 | RMSWSA |
| Butte—Texas Pacific 1 S. Anderson, 12-18n-5e | 5,700 | N.G.C. | 1950 | RMSWSA |
| Butte—Amerada 1 State, C NW NW 4-14n-4e | 7,760 | G.R.C. | 1953 | Amerada |
| Corson—Shell 1 Winter, C NW SW 11-22n-19e | 8,400 | G.E.C. | 1952 | OKWSA |
| Dewey—Kerr-McGee 1 W. Cook, SW NW SW 32-13n-22e | 5,990 | S.S.C. | 1953 | Kerr-McGee |
| Perkins—Shell 1 Homme, 13-20n-12e | 9,330 | Petty | 1951 | OKWSA |
| Stanley—Carter 2 Stratigraphic Test, NW SE SE 12-9n-27e | 3,876 | Carter | 1940 | Carter |

## MONTANA

| | | | | |
|---|---|---|---|---|
| Big Horn—Union Oil 1 AL 1490, 3-6s-35e | 5,061 | United | 1952 | RMSWSA |
| Big Horn—Shell 1 Crow, 36-9s-37e | 10,850 | United | 1949 | Shell |
| Custer—Carter 1 Liscom Cr., NE SW SW 15-1n-45e | 6,300 | | 1952 | |
| Dawson—Texas Co. 2 N.P.R.R. "G" NCT, C NW SW 21-16n-54e | 10,181 | General | 1952 | RMSWSA |
| Dawson—Texas Co. 1 N.P.R.R. (NCT-2), 21-16n-54e | 7,500 | Texas Co. | 1952 | RMSWSA |
| Dawson—Texas Co. 1 N.P.R.R. (NCT-3), 17n-50e | 10,885 | G.C.C. | 1952 | Texas Co. |
| Fallon—Montana-Dakota 1 N.P.R.R., SW NE NE 17-4n-62e | 8,110 | S.S.C. | 1940 | Carter |
| Fallon—Carter 1 Montana-Dakota Utilities, 17-4n-62e | | Carter | 1951 | Carter |
| Fallon—Texas Pacific-Pure 1 Cox, SW SE 23-3n-61e | 9,700 | Rayflex | 1951 | RMSWSA |
| Fergus—Cities Service 1 Huffine, 27-17n-15e | 5,916 | S.S.C. | 1953 | Cities Service |
| Garfield—General Petroleum 5-25-P Freedom, 25-16n-38e | 9,015 | W.G.C. | 1949 | RMSWSA |
| Hill—General Petroleum 36-12-P Erickson, C SW NE SW 12-36n-15e | 6,304 | Petty | 1952 | RMSWSA |
| Hill—Seaboard 1 Dolezal, 21-35n-10e | 5,387 | RMSWSA | 1953 | Seaboard |
| McCone—Stanolind-Amerada 1 Northern Pacific, C SE SE 5-20n-45e | 9,393 | Western | 1953 | RMSWSA |
| McCone—Hodge-Smith et al. 1 Eggebrecht, C SW SE 3-23n-49e | 10,000 | United | 1953 | RMSWSA |
| Musselshell—Cities Service 1 Nelson, NE NW 25-5n-24e | 7,160 | Petty | 1952 | Cities Service |
| Phillips—Continental 1 S. Zortman, SE SE NW 29-23n-26e | 6,481 | S.S.C. | 1952 | Continental |
| Powder River—Stanolind 1 N.P.R.R., C SE SW NW 27-2s-50e | 7,365 | Geotec Corp. | 1945 | Pure |
| Prairie—Texas Co. 1 Macioroski, C NW SW 23-16n-50e | 10,752 | General | 1952 | Texas Co. |
| Richland—Shell 22-29 Etzel, C SE NW 29-26n-51e | 10,114 | Shell | 1952 | Shell |
| Rosebud—Carter 1 Max Schenk, C NE NE 20-5n-40e | 7,715 | Carter | 1952 | OKWSA |
| Rosebud—Texas Co. 1 Lorigan, C NW SW 17-7n-38e | 6,710 | Texas Co. | 1950 | Texas Co. |
| Roosevelt—Continental 2 Fast, C NW SW 14-30n-46e | 6,576 | S.S.C. | 1953 | Continental |
| Roosevelt—Carter-Phillips 1 West Poplar, C NW SW 18-29n-50e | 7,552 | Carter | 1952 | Carter |
| Roosevelt—Murphy Corp. 1 East Poplar Unit, C SW NE 2-28n-51e | 9,163 | Seis. Anal. | 1952 | Murphy Corp. |
| Roosevelt—Murphy Corp. 1 West Poplar Unit, 18-29n-50e | 7,552 | Inter-Ex. | 1952 | Carter |
| Sheridan—Hunt 1 Hagan, C NE NW 7-34n-52e | 9,470 | United | 1952 | Union |
| Stillwater—Superior 71-22 Copulos, 22-2n-21e | 4,938 | S.S.C. | 1950 | Superior |
| Valley—Gulf 1 Cornwall, C SW NE 14-30n-38e | 7,010 | Gulf | 1952 | Gulf |
| Wibaux—Shell 1 Pine Unit, SW SW NE 30-12n-57e | 9,744 | Shell | 1951 | RMSWSA |
| Yellowstone—Cities Service 1 Cleveland, C SE NE 11-4n-25e | 8,066 | S.S.C. | 1953 | Cities Service |

## MANITOBA

| | | | | |
|---|---|---|---|---|
| California Standard 15-16 Hardgrove, LSD 15, 16-11n-27wPM | 2,927 | W.G.C. | 1951 | Calif. Standard |
| California Standard 5-18 Woodworth Province, LSD 5, 18-9n-27wPM | 3,646 | W.G.C. | 1952 | Calif. Standard |
| California Standard 2-21 Linklater, LSD 2, 21-7n-28wPM | 4,960 | W.G.C. | 1952 | Calif. Standard |
| Souris Valley 1 Moore, LSD 5, 20-1n-27wPM | 5,856 | G.S.I. | 1949 | Souris |
| California Standard 7-12 Daly, 12-10n-28wPM | 2,529 | W.G.C. | 1951 | Calif. Standard |
| California Standard 4-14 Ewart, LSD 4, 14-8n-28wPM | 4,817 | W.G.C. | 1951 | Calif. Standard |
| California Standard 3-1 Wawanesa, 36-7n-18wPM | 3,814 | W.G.C. | 1951 | Calif. Standard |

## SASKATCHEWAN

| | | | | |
|---|---|---|---|---|
| Hudson's Bay Oil & Gas 1 Gronlid, LSD 15, 32-47n-17w2M | 2,589 | Atlantic | 1950 | Hudson's Bay |
| Co-Op 1 Cypress Hills, LSD 14, 2-3n-25w3M | 5,175 | Ind. Exp. | 1950 | Alberean |
| Tide Water 1 Dundurn Crown, LSD 4, 22-31n-5w3M | 3,040 | Petty | 1951 | Tide Water |
| British American-Husky-Phillips 1 Bemersycle, LSD 3, 11-13n-8w2M | 5,737 | Delta | 1952 | Calif. Standard |
| Socony-Imperial-Western Prairie 1 Carievale, LSD 16, 4-3n-32wPM | 8,322 | G.S.I. | 1952 | Socony-Vacuum |
| Tide Water 1 Morse Crown, LSD 16, 25-16n-8w3M | 6,250 | Sub.-Sur. Expl. | 1952 | Tide Water |
| Tide Water 1 Johnston Lake Crown, LSD 9, 20-12n-2w3M | 6,010 | Petty | 1951 | Tide Water |
| Socony-Vacuum 1 Star Blanket, LSD 15, 6-23n-10w2M | 5,908 | Expl. Consult. | 1952 | Socony-Vacuum |
| Bennett Burns and B. L. Young 1 Bell, LSD 11, 19-5n-14w2M | 5,045 | Expl. Consult. | 1953 | Socony-Vacuum |
| Socony-Western Prairie 12-10B NW, Midway, LSD 10, 12-15n-20w3M | 3,913 | G.S.I. | 1952 | Socony-Vacuum |
| Socony-Sohio 1 Roe, LSD 5, 28-5n-21w2M | 6,754 | U.G.C. | 1953 | Socony-Vacuum |
| Socony-Central Leduc-Del Rio 1 Lake Alma, LSD 6, 10-3n-17w2M | 6,075 | U.G.C. | 1953 | Socony-Vacuum |

Compiled with the assistance of Society of Exploration Geophysicists, Colin C. Campbell, executive secretary, Tulsa. RMSWSA—Rocky Mountain Seismic Well Shooting Association. OKWSA—Oklahoma-Kansas Well Shooting Association.

of each cultivated farm over most of the Williston basin.

**Tertiary cover . . .** Immediately below the glacial drift lie great thicknesses of Tertiary cover made up of sands and shales; thickness of Tertiary rocks may range up to as much as 2,000 ft. During Quaternary time, extensive dissection of the old Tertiary surface resulted in formation of a large number of stream channels which were filled with reworked Tertiary or detrital material and later with glacial drift. Lyons states in the vicinity of Mandan the Missouri River channel has been found by seismic refraction data to be filled to a depth in excess of 500 ft. These innumerable channels and sinks in the Tertiary sediments gave rise to a wide range of velocities. Little relationship exists between these partially buried **low-velocity** zones and the normal **low-velocity** weathered layer.

Uphole velocity surveys reveal presence of thick layers of material with a velocity range from 3,000 to 5,500 ft. per second extend to depths of 600 ft.; these in turn are covered with a 150-ft. thickness of normally low-velocity near-surface material.

**Lithology . . .** Vertical velocity variations result from contrasting variations in the lithology of the Tertiary rocks. Many porous sandstone stringers and porous coal beds are found throughout the Tertiary section in the Williston basin. Where porous layers outcrop in bad-land topography and in deep coulees, they drain interstitial water out of the formations thus lowering vertical velocity. Lateral extent of this condition is shown by uphole velocity surveys which indicate this condition exists more than 1 mile from the outcrop of the Tertiary in question.

**Corrections . . .** Refraction method of checking uphole times is employed in solving routine near-surface corrections. Long refraction shots are taken in shot holes from one half to three half spreads beyond the ends of the split spread.

### Cedar Creek Anticline

Variations in near-surface velocities pose the principal seismic problem in the Cedar Creek anticline portion of the Williston basin.

**Record quality . . .** Field experience to date indicates that record quality has been fair to good. Generally, the Montana portion of the basin yields fair to good quality reflections and this is also true of extreme western North Dakota. Seismologists believe that use of multiple seismometers can materially improve record quality.

Tertiary cover effects are variable. Where the Cretaceous Pierre shale is present, record quality is excellent. However, with a mantle of Tertiary Fort Union, reflections range from fair to poor.

**Shooting character . . .** In this portion of the Cedar Creek anticline about three-fourths of the total crew-months during 1953 was devoted to continuous profiling and the remainder to correlation shooting.

Shot-hole depths range from as shallow as 80 ft. to as deep as 350 ft. depending upon elevations. Very close velocity control is used for determination of optimum depth for shot holes.

Uphole times checked by refractions are used in applying surface corrections.

During the winter period, operations are curtailed to about 80 per cent of summer seismic production due to the limited amount of available main roads in the region.

### Nesson Anticline

Problems encountered in the Nesson anticline area of the Williston basin are (1) near-surface velocity variations, and (2) variations in character and arrival times of reflections with changing hole depth. Record quality is generally good and generally is not affected by Quaternary cover.

Nearly all of seismic work conducted on the anticline is continuous profiling.

In the Nesson anticline area, depth requirements for shot holes vary from 250 to 350 ft., depending upon surface beds. Mayhew 1,000 shot-hole rig, or its equivalent, is employed. Very detailed velocity control is utilized for shot-hole depth determinations. Uphole corrections are checked by refraction method.

Winter cuts production efficiency of crews 30 per cent on the plains. Snowplows are often required to clear drifts.

### Eastern Limb Area

Near-surface velocity variations present the principal seismic problem in the eastern limb of the Williston basin. This portion of the basin is characterized by marked pinchout of formations of Lower Paleozoic age beneath the Cretaceous and Quaternary cover.

Record quality is good and no trouble has been encountered from Quaternary cover. Generally no Tertiary cover is present.

Shot-hole depth requirements range from 120 to 250 ft. Shot-hole depth requirements are determined by close control through uphole surveys. Surface corrections applied in this area are uphole times checked by refractions.

Winter operations have cut seismic production only 10 per cent under summer output.

### Canadian Provinces

In conducting seismic work in the Manitoba and Saskatchewan portions of the Williston basin, the following problems are prevalent: (1) near-surface travel-time corrections; (2) change in thickness of evaporite section in Paleozoic formations; and (3) difficulty in carrying desirable geologic markers.

Record quality is generally good in the plains-provinces portion of the basin although glacial drift cover affects record quality locally on a considerable extent. Tertiary cover generally exhibits little effect on record quality.

Hole-depth requirements are only 50 to 80 ft. in the flat plains area. However, depth ranges up to 500 ft. are necessary in glacial drift areas and in hilly areas.

Uphole times, refractions and isopach studies are made using shallow reflections in applying or eliminating surface corrections.

Seismic production is reduced 20 per cent during the winter. In the spring thaw period, production is 40 per cent off from the volume normally conducted during the summer months.

### Current Activities

Seismic activity in 1953 in the Williston basin continued at a high level. Operators, however, are concentrating on the Montana portion of the basin at the present time rather than in North Dakota. This shift in seismic work is probably caused by recent discoveries in eastern Montana and will continue throughout 1954.

### Acknowledgments

Thanks are extended to a number of seismic contractors who furnished data used in this article. Special acknowledgments are made to R. W. Mossman, chief geophysicist, Seismograph Service Corp., Tulsa, for reading the manuscript and offering valuable constructive criticism. Paul L. Lyons, exploration department manager, Anchor Petroleum Co., Tulsa, checked the regional structure map of the basin contoured on top of the basement complex. Stanolind Oil & Gas Co. furnished field photographs for the article.

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# SELECTED DIGESTS . . .

. . . of papers presented at the joint annual meeting of the American Association of Petroleum Geologists, the Society of Exploration Geophysicists, and the Society of Economic Paleontologists and Mineralogists, St. Louis, April 12-15.

## A.A.P.G., St. Louis

### Occurrence of Oil and Gas and Its Relations to Possible Source Beds In the Continental Tertiary of the Intermountain Area

WAYNE M. FELTS, The Texas Co., Houston.

WITHIN the intermontane basins of Intermountain area, the Great basin, and the Columbia plateau are enormous volumes of Tertiary continental sediments. These sediments may be classified on the basis of depositional loci into two general categories: (1) suites of sediments deposited in large lakes which in their later history became saline, and (2) basin fills of fluvial, paludal, and fresh-water lacustrine beds associated with varying amounts of extrusive volcanics.

To sediments of the first type are attributed many of the properties of marine strata. They commonly contain pyrobituminous shales and dolomites, truly petroliferous shales and dense limestones, tar sands, and various semisolid or solid bitumens. Oil and gas production has been established from such beds and closely associated strata. While some of this hydrocarbon content in local areas may have migrated into place from subjacent marine strata, most of such occurrences are considered indigenous.

Sediments of the second type commonly are either lacking in hydrocarbon content or contain methane gas which can be shown to be entrapped emanations from intercalated lignitic beds or other swamp deposits. In the Columbia plateau where beds of Miocene age are intercalated with a thick series of basalt flows, tarry residues from the distillation of organic matter have been mistaken for shows of oil.

### The Origin of the Hydrocarbons of the Uinta Basin, Utah

JOHN M. HUNT, FRANCIS STEWART, and PARKE A. DICKEY, Carter Oil Co., Tulsa.

THE Eocene sediments of the Uinta basin, Utah, consist of fluvial and deltaic red and green shales and sands around the margins of the basin and bituminous siliceous dolomites in the center. The latter, called Green River "oil shales," were deposited in a salt lake, probably chemically stratified, which occupied this area during Eocene time.

Asphalts and oils ooze from outcrops of the Eocene and are found in joints, veins, fissures, crystal cavities, and in pores of sandstones. There are four chemically different types of these free hydrocarbons. Each type is found closely associated with one particular stratigraphic unit, so that the source rock of each type can be identified by field geology. In addition to the free hydrocarbons, there are other hydrocarbons that can be extracted by organic solvents from the sediments of the various stratigraphic units.

Chemical data such as infrared spectra, elemental analyses, and various physical properties show that the extract from each unit is identical to the free hydrocarbons from the same unit, but differs from the extracts and free hydrocarbons of the other units. These chemical data, together with the supporting geological data, are believed to constitute an identification of the source rocks of the Uinta basin hydrocarbons.

It also was found that the changes in the chemical character of the hydrocarbons correlate with changes in lithology and therefore appear to be due to changes in depositional environment. There is no evidence that the differences in the hydrocarbons are a result of metamorphism, catalytic cracking, or depth of burial.

### Production From Nonmarine Beds In the Appalachian Belt

O. L. HAUGHT, West Virginia Geological Survey, Morgantown, W. Va.

ALMOST all production of petroleum in the Appalachian region comes from a shore zone of fairly rapidly deposited clastic sediments of late Devonian, Mississippian, and Pennsylvanian age. It is often difficult to determine whether a productive sandstone lens of this region is marine or nonmarine, since cores have not been taken and the horizon of the bed in question may not outcrop within many miles of the productive area.

A few productive beds are nonmarine, at least where productive. In these, accumulation is localized by lithology mainly, since structure is very weakly developed. The oil contained in such nonmarine beds has probably moved into them from marine source beds.

Most nonmarine productive sandstones of the Appalachian region are probably continuous laterally with marine sandstones, so that movement through relatively impermeable beds was not necessary in order to charge them with petroleum from marine source beds.

### Occurrence of Oil In Nonmarine Beds In the San Joaquin Valley

JOHN H. BEACH and VICTOR CHURCH, Oceanic Oil Co., Bakersfield, Calif.

AN estimated 1½ billion barrels of oil has been produced from nonmarine beds in the San Joaquin Valley. This compares with total production of 2½ billion barrels of oil from marine beds. Comparative estimates of present reserves are placed at 570,000,000 bbl. for the marine beds. More than 90 per cent of the production from nonmarine sediments has been obtained from beds of Pleistocene, Pliocene, and uppermost Miocene age and includes the Tulare, San Joaquin, Kern River, and Chanac formations. Most of the remainder of the oil produced from nonmarine beds is obtained from the Zilch (middle Miocene), Tecuya (Oligocene?) and Walker (lower Miocene) formations. Gravity of the oil ranges from 10° to 37°; however, the greatest amount of oil produced is of gravity below 16°. Geological relations indicate that the nonmarine beds commonly, but not invariably, interfinger with marine sediments basinward and suggest both regressive and transgressive marine-nonmarine relations.

### Symposium on Inclined Oil-Water Tables

#### Introductory Remarks

M. KING HUBBERT, chief consultant, Shell Oil Co., Houston.

DURING the history of the petroleum industry, geological thinking concerning the migration and entrapment of petroleum has oscillated between hydrostatic and hydrodynamic premises. Until about 1915, hydrostatic premises predominated. From then until about 1930, the "hydraulic theory" exercised considerable influence but never received adequate confirmation, and, during the past 20 years, hydrostatic premises have again become dominant.

Theoretical studies have led to a more general view; namely, that oil and gas can migrate and become entrapped under either hydrostatic or hydrodynamic conditions, but that the positions of traps in a hydrodynamic environment may differ markedly from those under hydrostatic conditions. The basis for these conclusions has already been presented, along with evidence that hydrodynamic effects are much more widespread than commonly had been supposed.

### Oil and Gas Production From Carbonate Reservoirs

FRANK B. CONSELMAN, consulting geologist, Abilene, Tex.

DESPITE the relative emphasis on reefoid masses in recent research and development programs, approximately 20 to 25 per cent of the world's reserves are believed to be contained in nonreef carbonate rocks.

For general purposes, carbonates are classified broadly as of chemical, evaporative, biochemical, organic, and clastic origin, with examples cited. Although there are classic examples of limestones and dolomites which preserve their lithologic and stratigraphic character for thousands of square miles, probably the majority will exhibit some type of facies differentiation within relatively short distances, both vertically and horizontally. These facies changes provide excellent stratigraphic trap possibilities, even in nonreefed rocks.

Oil and gas reservoirs in carbonates may be caused by the structural deformation of rocks having widespread, relatively uniform, intergranular porosity; by the development of fracture and fissure systems at favorable positions with respect to fluid migration; and by permeability pinchouts in connection with facies changes.

Secondary-recovery programs are proving successful in carbonate reservoirs as well as in sands, but the effect of fracturing and channeling must be considered to avoid bypassing large reservoir volumes. Reservoir heating techniques may prove to be applicable.

In future prospecting, applied sedimentology may have as large a field in the carbo-

nate rocks as it has had in the clastics. Practical "trendology" will also be useful, in addition to the conventional fold-finding techniques which have dominated exploration methods in the past.

### Geologic Framework of the Gulf Coastal Plain of Texas

**J. A. WATERS, P. W. McFARLAND, and J. W. LEA, Sun Oil Co., Dallas and Corpus Christi.**

THE area represented by the Gulf Coastal plain of Texas is bounded updip by the outcrop of the oldest Upper Cretaceous beds, downdip by the outer margin of the present Continental Shelf, east and west by the Louisiana state line and Rio Grande. Paralleling the inner margin of the coastal plain and beneath beds of Cretaceous age lies the Ouachita folded belt. These partially truncated Ouachita folds served in part as the foundation on which the Mesozoic and Cenozoic sediments were deposited.

Regional tectonics controlled the ancient geological features and their associated sedimentary processes. Peneplanation at the close of some periods was followed by intense rejuvenation of the land areas which resulted in long periods of deltaic activity. This, together with the downwarping, faulting, and slumping along the successively younger continental shelves resulted in structural conditions, blanket, and lensing sands which offer ideal conditions for the trapping of oil and gas. The closed basins and embayments received evaporite and/or reef development to a minor degree. The migration of the geosyncline southward to its present position with each period of deposition resulted in the great thickness of sediments underlying the Gulf Coastal plain.

The structural, isopach, and isolith maps based on the deepest well control illustrate the following conclusions: (1) The present structural position of the formations from the beginning of the Jurassic to the close of the Miocene epoch, (2) the thickness and rate of thickening of these sediments gulfward indicating the structural position of the top of each formation on which each succeeding formation was laid down, and (3) the ratio of sand to shale showing the regional facies changes, which combined with stratigraphy may be interpreted as geologic sedimentary features.

### Hydrodynamic Analyses Applied to Oil Exploration and Prospect Evaluation

**GILMAN A. HILL, president, Petroleum Research Co., Denver.**

THE common occurrence of hydrodynamic conditions causing inclined oil-water contacts, especially in the Rocky Mountain region, requires the use of new exploration and prospect-evaluation methods. The physical principles of oil entrapment under hydrodynamic conditions are easily understood when explained qualitatively by means of vector force diagrams. That is, the buoyancy of oil is a vector force acting in a vertical direction, the movement of water in the aquifer produces a vector force acting in a direction approximately parallel to the bedding plane, and the oil-water contact is perpendicular to the vector sum of these two forces.

This combination of forces, resulting in an inclined oil-water contact, may (1) cause oil production to extend in the gradient direction beyond the previously assumed limiting contour, (2) force the oil pool away from the highest point of the structure and to the position of minimum potential energy on the flank or nose of the structure, or (3) lift the oil pool completely out of the structure leaving it barren of oil.

It is concluded that in the Rocky Mountain region hydrodynamic gradient analyses must be integrated with structure mapping and stratigraphic studies to properly evaluate all prospects and to find new prospects including nose or flank possibilities on structures previously condemned by dry holes.

### Inclined Fluid Contacts in the Mid-Continent Region

**WILLIAM L. RUSSELL, professor of geology, Texas A. & M. College, College Station.**

IN the Mid-Continent region inclined fluid contacts are known in three regions, namely, in northeastern Oklahoma, in the region extending from West Texas to Hugoton field, and in South Texas. In general, the inclined fluid contacts dip in the direction of the regional dip. An analysis is given of the time relations involved. The conclusion is reached that some of the inclined contacts are not produced by artesian currents.

### A Seismic Reflection Quality Map of North America

**PAUL L. LYONS, Anchor Petroleum Co., Tulsa.**

A REFLECTION quality map of North America has been prepared which brings to date the map of the United States prepared for the April meeting of the S.E.G. in 1951, and the remainder of the continent has


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been added. The map designates as good, fair, or poor to NG all sedimentary areas of the continent in respect to reflection quality in conventional seismic explorations.

A ready correlation is apparent between the areas of intensive oil and gas development and areas of fair to good reflection quality. The rapid oil and gas developments in recent years in western Canada may be directly ascribed to the unexpectedly good seismic data obtained. The committee notes the invasion of the poor to NG areas by the use of special techniques and the reward to be gained by progress in this direction, for approximately half of the sedimentary area of North America yields poor to NG reflections.

## Edgewater Relations in Bradford Field, Pennsylvania

**CHAS. R. FETTKE, professor of geology, Carnegie Institute of Technology, Pittsburgh.**

THE oil and gas, accumulated in the coarser layers represented by the sandstone, while the salt water passed on. Sufficient oil was available to almost fill the stratigraphic trap that existed. Diagenesis and lithification accompanied the compaction. Oil accumulation was probably well under way during Mississippian time and may even have been nearly completed by Pennsylvanian time before some of the present structural features came into existence. The anomalous occurrence of salt water around the margins of the pool with respect to the present elevation of the sand is thought to be due to static factors.

## Carboniferous Formations and Faunas of Central Montana

**W. H. EASTON, Geologist, U. S. Geological Survey, University of Southern California, Los Angeles.**

POST-MADISON representation of Carboniferous strata was studied in the Big Snowy and Little Belt Mountains to assist in correlating subsurface studies in the Williston basin.

As originally defined, the Big Snowy group consisted, in ascending order, of the Kibbey, Otter, and Heath formations. Strata of the so-called Amsden formation overlying the Big Snowy group in Central Montana are not continuous in outcrop with nor have been proved to be equivalent to Amsden strata of the type section. Paleontologic evidence shows that lower shaly strata of the so-called Amsden are in part equivalent to the Heath formation and that elements of the Chester faunas extend up into the upper carbonate strata of the so-called Amsden formation; therefore, extensive revisions of stratigraphic boundaries and names are under way.

The oldest formation in the Big Snowy group that has been dated by fossils is the Otter formation, which is of Chester age. The youngest strata of the Big Snowy group may be Pennsylvanian.

## Evidence of Older Structural Development in Williston Basin

**K. R. PARSONS, Williston Oil & Gas Co., Casper, Wyo.**

ALTHOUGH data are as yet rather limited, there are erosional and/or depositional irregularities in a number of the areas which have seen development thus far within the Williston basin to indicate several periods of tectonic evolution during the Paleozoic era.

On the Baker-Glendive (Cedar Creek) anticline, prominent northwest-southeast trending fold some 110 miles in length in eastern Montana, Devonian sediments have in places been completely truncated, along with the upper portion of the Silurian Interlake formation, and later movement is apparent which affected the Mississippian formations. Thrust faulting has been established along the west flank of this asymmetrical structure. At the present stage of development production is limited to minor local closures along the crest, with oil found in carbonates of the Mississippian, Silurian, and Ordovician periods.

Poplar dome, which lies 70 miles north of Deer Creek, the northernmost producing area of the Baker-Glendive trend, is the outstanding structural feature in northeastern Montana. Here there has been insufficient deep drilling for a complete picture, but Mississippian structural development is apparent. This is a double crested high with production thus far limited to the eastern crest, from carbonate reservoirs of Mississippian age.

The Richey anticlinal trend, 40 miles northwest of Deer Creek, has a northeast-southwest orientation, at right angles to the Baker-Glendive structure. This feature also shows evidences of folding during Silurian, Devonian, and possibly Mississippian deposition. Present production is from carbonate reservoirs of at least one of these periods and the Ordovician, developed in limited areas along a trend some 13 miles in length.

The Tioga-Beaver Lodge-Cross north-south anticlinal trend in northwestern North Dakota, 50 miles east of the Montana State line, is the major structural feature in the center


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of the Williston basin. Here again Devonian and Mississippian movements are in evidence. This is the outstanding producing area in the basin at the present time with production extending from the vicinity of Tioga 55 miles southward to the Little Missouri River. Development in the Tioga-Beaver Lodge areas covers a trend 21 miles long and 3 miles wide. Present production is mainly from Mississippian carbonates, with additional prospective zones already established in carbonates of the Devonian, Silurian, and Ordovician periods.

The foregoing structural developments with their subsequent stratigraphic ramifications are considered to have been primary factors governing the accumulation of oil in the producing fields thus far discovered within the Williston basin.

### Analytical Comparisons of Crude Oils From the Williston Basin

**RAY T. WENDLAND, ROBERT F. RYAN, and WILLARD D. PYE, North Dakota Agricultural College, Fargo.**

THREE samples of crude from Tioga field, two samples from Beaver Lodge field, and one sample from Croff field, all of North Dakota, were analyzed. The crude in all cases came from the Mission Canyon formation (Mississippian) at depths ranging from about 8,000 to 9,500 ft.

Geologically, the tests show that so far as the analytical characteristics of the crude oil from present producing section of the Mission Canyon formation of the Tioga, Beaver Lodge and Croff fields of the Nesson anticline, North Dakota, are concerned, the composition is essentially the same.

### Little Beaver Creek Field

**GEORGE H. FENTRESS, geologist, Lion Oil Co., El Dorado, Ark.**

LITTLE BEAVER CREEK FIELD lies in the Denver-Julesburg basin. The field was discovered by promotional means without the aid of seismograph or surface work. Subsurface control was too sparse to be an aid. Snowden and Tucker drilled the discovery well in September 1950. Minor quantities of oil were tested in the "D" sand, although the well was a gas completion in the "J" sand. Slow and discouraging exploitation followed until late spring, 1952.

By January 1, 1954, there were 82 oil wells completed or in the process of completion and 8 shut-in gas wells in the two sand members. From 85 of these wells, 2,727,350 bbl. of oil has been produced to January 1, 1954. Consequently, this became the largest field in the basin and the second largest in Colorado. The "D" and "J" sands are members within the Dakota group of Cretaceous age and are alphabetically designated in order to avoid nomenclature confusion. The "D" is the first Dakota sand member and is productive on the east side of the field while the "J" is the second Dakota sand member and is productive on the west.

Oil, gas, and permeable sand accumulations are found as a sand-bar type of stratigraphic trap on a prominent nose or terrace-type feature where little or no reversal has been noted. The saturated "D" sand varies from 6 to 50 ft. within a maximum "D" thickness of 62 ft.

The saturated "J" sand varies from 2 to 24 ft. in what is called a first-bench development. There are minor quantities of oil and gas in a second bench. There are approximately 1,540 oil-productive "D" acres and approximately 960 oil and gas-productive acres in the "J." A moderate recovery figure is 300 bbl. of oil per acre-foot and 700 M.c.f. of gas per acre-foot. These figures are approximately 30 per cent of total oil in place. Water is at this time a negligible item but does apparently constitute a minor drive. The "J" sand has a gas-cap drive but the major driving mechanism is gas in solution. The intense activity now present in the area testifies the great potential which this field has evoked.

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### The Ionium Method of Age Determination—Recent Developments

**HERBERT L. VOLCHOK and J. LAURENCE KULP, Lamont Geological Observatory, Palisades, N. Y.**

THE ionium method of age determination is based on the lack of equilibrium in the series uranium, ionium, and radium of freshly deposited sediments of the deep sea. The relative concentrations of these elements approach equilibrium ratios with time after deposition, thus a curve of radium concentration as a function of depth in the core should exhibit a shape in accordance with known radioactive equilibrium theory. The most reliable dates appear to be obtained from cores homogeneous in sediment type and uniform in their depositional rate.

Surface-area measurements have been made on the material of two cores dated by the ionium method. The results point to

adsorption as the mechanism of ionium enrichment. In the case of the "ideal" core, the surface area was found to be relatively constant throughout its length. The second core which exhibits anomalous concentrations of radium at several depths was found to have a direct relationship between radium and surface area in the upper, youngest section.

Since the theory of the ionium method is concerned only with ionium derived from the ocean water, any ionium contained within the rock particles prior to its oceanic deposition is in excess, and will cause further anomalies in the radium-depth curve. Therefore, studies of the ratio of adsorbed to total radium of the core material are now in progress. It is hoped that quantitative measurements of this ratio will permit ionium dating of cores not previously usable.

## Subsurface Formation Density Logging

**G. R. NEWTON, J. E. SKINNER, and D. SILVERMAN, Stanolind Oil & Gas Co., Tulsa**

AN instrument for logging the densities of subsurface formations in drilling wells, which utilizes the absorption of gamma rays in the rock as a function of density, has been developed. Calibration of the instrument is carried out in a series of model wells formed in materials of various known densities. Response of the instrument is affected by hole size, so that a caliper log of a well is used interpretively to compensate for varying hole diameters. Methods for automatic diameter compensation have been devised.

Close contact between the instrument and the bore-hole face is required for accurate measurement. This condition is readily obtained in smooth bore holes where comparisons of logged densities with densities measured on cores showed differences averaging of the order of 0.05 g. per cc. In rough-walled sections the average difference was somewhat higher.

Calculations of formation porosities are made from the density log, based on an inverse relationship between density and porosity. The correlation obtained between log-derived porosities and measured core porosities indicates that the accuracy is sufficient to make this information useful for well completion decisions and oil reserve calculations.

## A Field Evaluation of the Electromagnetic Reflection Method

**ROBERT VAN NOSTRAND, Magnolia Petroleum Co., and ALBERT ORSINGER, Earl Lipscomb Associates, Dallas**

YOST ET AL. (Geophysics, XVII, pp. 89-103 and 806-826) outlined the general theory of electromagnetic wave propagation along an interface such as the air-earth boundary, and described model experiments.

Equipment similar to that described for the laboratory experiments has been assembled for field use. Two large loops, one for transmitting and the second for receiving, are laid on the surface of the ground. A pulsed current is passed through the transmitting loop. A similar arrangement of loops is placed on the surface of a metallic model and the signals received by the two receiving loops are mixed in opposition.

The layering in the model is then manipulated until the difference signal is a minimum, which condition signifies that the actual earth has been approximated in the model considering the appropriate scaling factors. Using this technique at five stations in Dallas County, Texas, where the depth of the Austin chalk-Eagle Ford shale contact varies from 50 to 400 ft., this depth was determined within an average accuracy of about 5 per cent.

## Transmission Characteristics Of Near Surface Layers, Barton County, Kansas

**ROBERT B. FISHER, Geophysical Research Corp., Tulsa.**

THIS method involves making measurements of earth materials in place, by examining pulses recorded at several depths in the earth adjoining a shot hole.

The recorded pulses were analyzed by means of a Henrici rolling sphere analyzer to obtain their Fourier spectra. Point-by-point division of two spectra yielded the transfer characteristic of the earth materials between two geophone positions.

A point of special interest is the extremely rapid attenuation of the high-frequency components of the waves in the very shallow layers of the earth.

## Geophysical and Geological Investigations in the Gulf of Mexico

**MAURICE EWING, J. L. WORZEL, D. B. ERICSON, and BRUCE C. HEEZEN, Lamont Geological Observatory, Palisades, N. Y.**

IN 1953 the research vessels Vema and Atlantis spent about 3 weeks in the Gulf of Mexico. Coring, seismic refraction, and topographic studies were undertaken. The results

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point to the southern half of the Gulf of Mexico as a typical ocean basin with a profound change at the foot of the continental slope. Many sediment cores longer than 30 ft. were taken in the Sigsbee Deep. The abrupt change separates approximately 3 ft. of Recent sediments from Wisconsin in which all cores ended.

### The Impulsive Response Of Planted Geophones

**R. G. PIETY, Phillips Petroleum Co., Bartlesville, Okla.**

IN the interaction between the ground and the geophone, experimental observations can show a wide range of variation in field practice. In general a tightly planted geophone is much more highly damped than a geophone resting on the surface. The impulsive response is obtained by dropping a small steel ball on the planted geophone. It is observed that in some cases the behavior indicates that reciprocity between the reception and transmission of a pair of differently planted geophones holds true.

### Reflection Quality, a Fourth Dimension

**BEN F. RUMMERFIELD, Century Geophysical Corp., Tulsa.**

THE quality of seismic reflection results has a direct relation to newer petroleum provinces in the North American Continent. An approach is suggested whereby a local seismic study of changes of physical characteristics of subsurface reflecting horizons can be attempted. The changes in the quality of deeper reflecting horizons in relation to a persistent shallow, or "control," horizon may be able to add a fourth dimension to present seismic interpretations.

### Recording of Seismic Waves In Bore Holes

**E. T. HOWES, United Geophysical Co., Pasadena, Calif.**

REFLECTED and refracted seismic waves are normally detected by a "horizontal spread" of geophones placed at the surface of the ground. However, these same seismic waves can be detected by a "vertical spread" of geophones suspended in a fluid-filled bore hole. Equipment specially designed for use as a vertical spread in shallow bore holes is described in this paper.

Sample records are shown. The relative advantages and operating problems are also discussed.

### A Magnetic Compounder For Directional Discrimination Of Seismic Waves

**C. C. LASH, T. H. GILMARTIN, and J. D. EISLER, Stanolind Oil & Gas Co., Tulsa.**

THE magnetic compounder is a multiple-trace magnetic recording and playback device which provides discrimination between seismic waves based on their direction of arrival. The device makes a temporary recording of the signals from 12 groups of seismometers. The continuously moving magnetic tracks carry the signals to a large array of pickup coils before erasing. These coils are connected so as to add their outputs with a systematic pattern of time delays. By this means, the recording is analyzed into components on the basis of movement, i.e., differences in arrival time.

The magnetic compounder has been tested with procedures intended to lead to routine field use. Since the device is inherently capable of improving the ratio of reflected energy to the extraneous seismic noise by virtue of its directional sensitivity, the instrument was field tested in various areas to evaluate its capability of resolving dip as well as to carry correlation analysis.

The use of the magnetic compounder in research work is illustrated as a method for emphasizing and separating surface waves.

### Recent Results of the Model Seismology Program at the Lamont Geological Observatory

**JACK E. OLIVER, FRANK PRESS, and MAURICE EWING, Lamont Geological Observatory, Palisades, N. Y.**

AT the Lamont Geological Observatory elastic wave propagation is investigated by means of pulses of ultrasonic frequencies traveling through small scale models. The use of two-dimensional rather than three-dimensional models greatly enlarges the scope of investigations. Two-dimensional models are cheaper and more readily available, require less space, are easy to fabricate, require less elaborate electronics, and have a favorable ratio of compressional to shear velocity. Current applications of the seismic model, or analog computer, to specific problem of surface wave dispersion and reflection and refraction of body waves are discussed.

### Duck Lake Field—St. Martin Parish, Louisiana

**EDD R. TURNER, JR., Humble Oil & Refining Co., New Orleans.**

THE Duck Lake geologic structure was found sometime before the war by reflection seismograph, and an exploratory well was drilled in the area in 1941 which logged gas shows but was abandoned. Humble Oil & Refining Co. conducted gravity and seismograph surveys in the area after the war and drilled two dry exploratory wells in 1947. The discovery well was completed by Humble in 1949, and since then 84 oil and gas wells have been drilled.

The Duck Lake structure is a dome-shaped closure between a large down-to-the-northwest fault which limits production on the north side of the field and a smaller down-to-the-southeast fault which limits but does not completely interrupt oil and gas accumulation on the southern side of the field. This smaller fault dies out "on structure."

Oil and gas accumulations are found in Miocene age sediments in the Bigenerina floridana, Uvigerina lirittensis, Robulus, Operculinoides and Discorbis zones. This interval extends from 8,000 ft. to almost 13,000 ft. There are recognized 14 gas sands, 6 oil sands, and 7 associated gas and oil sands (total 27). The field gas column is 1,693 ft. and the oil column is 430 ft.

### The Least Squares Approach to the Residual Analysis of Gravity Data

**THOMAS J. BEVAN, consultant, Tulsa.**

THE primary purpose of residual analysis is to bring out local anomalies of relatively small magnitude that would otherwise be overlooked or underevaluated because of the "shadowing" of a large regional gradient. It is extremely difficult to draw accurately a graphical estimation of the regional gradient and, at best, it contains considerable human error. By fitting a cubic surface to the regional pattern with a least squares process the residual values can be calculated analytically eliminating these human errors. Control points on the residual map can be made identical with the station control. The method is economical if punched cards and electronic calculators are used.

Examples of results are shown from the Rocky Mountain, Williston basin, southern Oklahoma, and Gulf Coast provinces.

## S.E.P.M., St. Louis

### Sedimentary Characteristics of Producing Zones in West Brock Area, Carter County, Oklahoma

**L. L. SLOSS and E. C. DAPPLES, Northwestern University, Evanston, Ill.**

THE West Lone Grove, Bayou, and West Brock fields lie along a structural axis trending southeast from the Hewitt anticline to the Criner Hills uplift. Closely spaced drilling and excellent electric log control provide data for detailed analysis of the producing zones and their relation to structural growth. The section concerned is the Deese, including the so-called "Lone Grove series." A cyclical succession, dominated by shale but including numerous sand bodies and minor limestones, is involved. The cycles are identified with their limestone members as recognized in outcrop.

Sands in the upper part of the section are shown to have a broad "blanket" distribution pattern with production confined to higher parts of closed structures. As the base of the Deese is approached discontinuous sand bodies are present and these have an irregular distribution of productive areas with respect to structure. Maps of numbers of sands, net sand thickness, and average sand thickness show a systematic pattern which is clearly related to the structural trend. Off-structure areas are characterized by high sand thicknesses with large numbers of sands present; higher areas exhibit small or gross amounts of sand confined in fewer individual bodies. In addition, the structurally higher areas are characterized by high rates of change in thickness and number. A combination of rates of subsidence with such environmental factors as waves and currents is invoked to explain the distribution patterns. The characteristics expressed within individual sands may be tested statistically for identification of significant variations.

### Petrology of Springer Oil Bearing Sandstones

**LYNN JACOBSEN, University of Kentucky, Lexington.**

THE oil-bearing sandstones of the Springer formation in several large southern Oklahoma oil fields seem to be petrographically distinct from the non-oil-bearing ones. In general they are coarser grained and more massive; they do not have a clay matrix, and characteristically they have placerlike concentrations of heavy minerals.

Siderite and pyrite are common in the Springer formation as a whole but are absent from the reservoir sandstones. Calcite, however, occurs with the reservoirs—as clastic grains and to a small extent as cement in the sandstones, and as interbedded thin limestone layers. These associated limestones are either oolitic or debris of benthonic fauna.

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type sandstones are on several large anticlinal uplifts, and the sandstones lose their distinctive character down the flanks of the anticlines. Slumped bedding is common on the anticlinal flanks. The character of the reservoir facies and the association of structure with rock type suggests that the loci of the distinctive sedimentation of the oil-bearing sandstones was on topographic highs formed by early movements of the uplifts.

It is suggested that the distinctive sandstone is the critical factor in the accumulation of the oil, and hence, that large Springer oil production will be found only on uplifts with a history of movements during sedimentation.

## A.A.P.G., Rocky Mountain Section

### Oil Frontiers in North Dakota

**CHARLES A. TALLARD, geologist, Continental Oil Co., Bismarck, N. D.**

THE entire State of North Dakota is an oil frontier, as Williston basin sediments cover nearly all of the state and every porous zone should produce oil under the proper conditions.

The surface geology can be divided into two main parts—the glaciated and unglaciated areas (Fig. 1). North and east of the Missouri River the glacial debris obscures the Tertiary and Cretaceous bedrock, and surface-structure mapping is impossible. South and east of the Missouri River carefully detailed mapping will locate many significant leads. This mappable area corresponds to the deeper part of the Williston basin as shown on the Greenhorn structure map (Fig. 2).

The Nesson anticline in the northwest corner of the state is the largest and most productive structural feature in North Dakota. To date production has been proved in the Mississippian, Devonian, Silurian, and Ordovician. The Mission Canyon (Mississippian) has proved the most prolific pay zone to date. It is producing at the Beaver Lodge, Tioga, Hufflund, Charlson, Keene, Croff, Fryburg, and North Landa fields.

Fryburg field is an example of a more or less isolated low-relief structure. There are undoubtedly many other similar structures that will prove productive in the future. Many of these structures will need the assistance of some type of stratigraphic barrier to prevent further migration of the entrapped oil. Many of the pay zones are lenticular and nearly all are truncated beneath the Triassic or Jurassic. These conditions will assist in the formation of stratigraphic traps similar to those found in Bottineau County, North Dakota (Westhope, North Westhope, and Northeast Landa) and Saskatchewan and Manitoba, Canada.

The location of significant surface structures, the multiple pay zones, the lenticular nature of many of the beds, and the truncation beneath the unconformities should encourage rapid exploration in North Dakota.

### Mississippian Oil Accumulations In Northern Montana

**JACK W. NORDQUIST, Phillips Petroleum Co., Billings, Mont.**

MISSISSIPPIAN reservoirs in northern Montana have produced oil in an amount almost equal to the combined total from all other producing zones. Six important fields, four in the Sweetgrass arch area and two in the Williston basin, currently yield a total of over 350,000 bbl. of oil monthly. Without exception, the producing zones are carbonate reservoirs which contain either intergranular, vuggy, or fracture porosity. A discussion of each field is presented to illustrate that stratigraphic variations are equally, if not more important, than structural closure in governing accumulation. The stratigraphy of the Mississippian is treated briefly to show regional correlation of the producing zones.

### The Williston Basin in South Dakota; An Oil Frontier

**FRANK W. FOSTER, Ohio Oil Co., Bismarck, N. D.**

OIL in commercial quantities has been found in South Dakota. The north-plunging Lemmon syncline, that is, the south end of the Williston basin, occupies the west half of South Dakota. Paleozoic sediments, the source of oil in North Dakota and in adjacent areas in Montana, are known in the subsurface of South Dakota and comprise roughly 37,000 sq. miles. Cretaceous sediments, which produce oil in Nebraska, occur throughout the state, over an area of about 77,000 sq. miles. Mesozoic and Paleozoic sediments may range up to 10,000 ft. in thickness.

Cross-sections indicate the wedging out of formations of Ordovician, Silurian, Devonian (?), Mississippian, and Pennsylvanian ages. These wedge ends should form porosity traps and be prolific sources of oil. A pre-Jurassic unconformity overlies the truncated edges of most, if not all, of the older formations. Oil reservoirs may be found here. Isopach maps indicate a wide areal distribution of several potential oil-bearing formations.

Surface structures are known, especially in the western part of the state, and also around the Black Hills and along the Missouri River. Some structures have been drilled.

Considering the great potential area for oil finding in South Dakota, only scattered drilling has so far been accomplished, and a few wells have tested the deeper possible oil and gas zones.

At present more wells are being drilled, seismic information is being accumulated, and surface parties are evaluating the areas of exposed Cretaceous and Tertiary rocks.

### Arizona, a Frontier Area

**SILAS C. BROWN, consultant, Durango, Colo.**

ARIZONA is divided into three parts according to its oil and gas possibilities based upon present knowledge. This paper gives only a brief mention of the Basin and Range provinces in the southern and western parts of the state and concentrates on the possibilities in the Plateau province in the northern part.

The major objective horizons in the Plateau province include the Fort Apache member of the Supai formation (Permian), Hermosa formation (Pennsylvanian), and the Martin formation (Devonian). The presence of a Permian salt basin in central eastern Arizona may open reef possibilities in the Supai. The Pennsylvanian formations have been disappointing to date due to the lack of good reservoir beds. Devonian possibilities appear greatest south of the Navajo-Hopi Indian Reservation and in general to the south and southwest of Holbrook.

The presence of old granite highs and ridges has proven exploration to be dangerous; however, this may be solved by a combination of aerial magnetometer, seismograph, and detailed stratigraphic studies.

**Distribution of surface formations in North Dakota. (Fig. 1).**

**Subsurface structure as contoured on the Greenhorn (Upper Cretaceous) in North Dakota. (Fig. 2).**

## Exploration Frontiers in Western Canada

**W. B. GALLUP, Royalite Oil Co., Ltd., Calgary.**

PROBLEMS are presented concerning exploration in the western part of the western Canada sedimentary basin, especially in the Alberta syncline and foothills belt. Some reference is made to certain problems elsewhere in the basin.

The area is seen as a true frontier both with respect to geography and geologic thinking. Problems of access and various exploration techniques peculiar to the wilderness areas are described. Geological thinking with respect to the syncline and foothills is changing rapidly and these approaches are discussed.

## Williston Basin Paleozoic Unconformities

**W. S. McCABE, Stanolind Oil & Gas Co., Casper, Wyo.**

THE Williston basin is primarily a Paleozoic basin. Regional Paleozoic unconformities are present in the basin at the base of the following: Cambrian, Ordovician, middle Devonian, lower Mississippian, middle Pennsylvanian, and middle Permian. The unconformity at the base of the Mississippian is the most pronounced of the regional unconformities.

## Oil and Gas Possibilities of The North Park Basin, North Central Colorado

**R. M. THOMPSON, Hiawatha Oil & Gas Co., Denver.**

STRATIGRAPHY of North and Middle Parks is contrasted to that of South Park for clarification of tectonic and structural differences. These differences may have had profound influence upon the accumulation of hydrocarbons.

Sediments of the North Park basin are analyzed because significant changes take place within short distances in potential reservoir rocks. Unconformable relationships exist in a profound extent in Tertiary and Upper Cretaceous rocks and their importance to accumulation of oil may be significant.

Petroleum development in the area has been sporadic and at times as spectacular as it has been disappointing. Development has served to indicate that carbon dioxide gas in one part of a basin does not necessarily condemn other portions. Significant discoveries may yet be made in this and similar intermontane basins because factors of stratigraphy and structure are favorable.

## The Little Beaver Field Area

**W. C. MacQUOWN, JR., Deep Rock Oil Corp., Denver.**

EXPLORATORY drilling in the rapidly developing Little Beaver field area of Adams and Washington counties, Colorado, has given rise to oil discoveries at Badger Creek, East Mountain View, and West Woodrow. These field discoveries and others to the northeast and northwest have revived interest in largely stratigraphically trapped oil in winnowed sandstone reservoirs of the Graneros and Dakota group south of the South Platte River. Previous discoveries in the general area at Middlemist and Lee fields had not held forth promise of large reservoirs in this portion of the Denver basin where structural closure, as determined by the seismograph, is close to the limits of error inherent in this method of prospecting, and where indicated structures are small.

Cross-sections, structural contour maps, and isopachous maps indicate stratigraphic-structural relationships conducive to commercial accumulation of gas and oil. However, the presence of numerous alternating shallow marine and continental environments of sedimentation makes mapping of the extension of existing fields difficult and the mapping of wildcat prospects a technique yet to be perfected.

## Geology of the Disturbed Belt of Southeastern Idaho

**MILTON ZENI, Standard Oil Co. of California, Salt Lake City.**

THE Disturbed Belt of southeastern Idaho is located on the eastern edge of the Cordilleran geosyncline. The structure and stratigraphy are quite similar to that found along the eastern edge of the Cordilleran geosyncline from Canada to southern Nevada. Oil is being produced from a similar structural environment at Turner Valley and Pincher Creek in Canada.

Southeastern Idaho can be divided into parallel zones of structural shortening. Synclinoria, characterized by long, narrow, asymmetrical doubly plunging folds, are separated by anticlinoria which have overdeveloped into zones of thrusting and imbricate faulting. Overthrusting, and imbricate faulting are uncommon in the synclinoria.

Limited isopach data indicate that southeastern Idaho, from southwest to northeast, contains rocks of basinal, marginal, and foreland thickness. Generally, the lithofacies maps tend to confirm these relationships.

Five unsuccessful wildcat wells have been drilled in the province which covers 4,000 sq. miles. Four of the five wells were drilled on anticlines located in the synclinoria, and one was drilled in the imbricate area. Although results to date have been somewhat discouraging, the area has not been completely tested. None of the wells have penetrated the Paleozoic section beneath the Mississippian-Madison limestone, and numerous large folds, offering multiple objectives, have not been tested.

## Gas and Oil Operations in the Uinta Basin of Utah

**DORSEY HAGER, consultant, Salt Lake City.**

THE Uinta basin of Utah is going into its fifth year of oil production. To date there is one field, Red Wash, of importance with nearly 8,000 acres proven and 24 producing wells which yield around 5,000 bbl. daily. Most of the production is choked down until transportation can take care of the situation.

Nearly 100 holes have been drilled resulting in the discovery of five oil fields, two possible oil fields, and two gas fields. The discovery rate is 7 out of 70 or 1 producer, or potential producer, out of 10 tests. Considering the 8,000 sq. miles in the basin the average dry density is one hole to 110 sq. miles. However, considering the proximity of dry holes to the nearby fields, the ratio is more nearly one to 400. There are nearly 20 sq. miles of proven area, or 1 sq. mile proven to 400 unproven.

Nearly all the fields are due to stratigraphic traps so that the situation for new discoveries is unique in that new fields should be of the same type.

The south rim of the basin has two gas fields in the Wasatch and in the Mesaverde beds. Conditions there are quite similar to those in the San Juan basin. It is possible that a major gas area may be developed on the south rim of the basin.

Drilling and operating costs are high in the basin due to transportation, and to the oil carrying high proportions of wax, 20 to 50 per cent, with pour points of 90° to 110°.

## Cedar Creek Anticline, Eastern Montana

**JOHN W. STRICKLAND, Continental Oil Co., Denver.**

THE Cedar Creek anticline is an elongate northwest-trending flexure approximately 100 miles long and 10 miles wide located in eastern Montana on the southwest flank of the Williston basin.

As expressed in surface beds of Upper Cretaceous age, the structure is an asymmetric fold with the steep side on the west. Minor structural closures occur along the axis. The general appearance is one of a long, narrow flexure typical of the compression-type Rocky Mountain anticlines.

Increased exploration for oil since the discovery of Glendive field in late 1951 has made available geologic data which reveal a considerably different structural development from what most geologists expected. The preparation and interpretation of isopachous maps, paleogeologic maps, and cross-sections indicate that the Cedar Creek flexure is not the result of compressive forces, but due to a sequence of events, i.e., vertical uplift and eastward tilting, normal faulting, extreme truncation, and finally, rejuvenation. The growth commenced in early Mississippian time and continued intermittently into Eocene time. The present structure is the resultant of several stages of structural movement which in many ways is similar to the structural development of the Nemaha ridge of Oklahoma and Kansas.

Until 1936 when the first discovery of oil was made in the Williston basin by the Montana Dakota Utilities Co. near the south end of the Cedar Creek anticline, the trend was thought of as gas producing only. Gas was first discovered in 1913 on Gas City dome about 10 miles south of Glendive, Mont. Since this date approximately 350 gas wells have been drilled. Most of the gas is being produced from the Judith River sandstone at an average depth of 900 ft. The present gas reserves on Cedar Creek anticline are approximately 60 billion cubic feet. Several of the wells had an initial potential of 25 million cubic feet of gas daily.

The 1936 oil discovery is reported to have flowed at the rate of 125 bbl. of oil per day with a small amount of water from the Madison limestone at a depth of 6,800 ft. The test was finally abandoned because of water trouble. Four other deep tests were drilled prior to 1951. All of the tests had good shows or actually produced some oil from either the Mississippian or Ordovician carbonates, but were soon abandoned because of water-shutoff difficulties. Altogether, several thousand barrels of oil were produced from these five tests.

It was not until the discovery by The Texas Co., late in 1951, that impetus was given the Baker-Glendive area. Since that time 50 tests have been drilled, of which 37 have been successful. These tests have revealed a thick stratigraphic column of potential reservoirs which includes the Winnipeg sandstone,

Red River dolomite, and Gunton dolomite of Ordovician age; Interlake dolomite of Silurian age; Jefferson dolomite of Devonian age; and limestone and dolomite of the Madison group of Mississippian age. Discoveries have been made in the Charles and Mission Canyon formations of Mississippian age, the Interlake group of Silurian age, and the Gunton and Red River formations of Ordovician age. Currently most of the production is from the Red River formation.

At present seven of the several surface or seismic structures have been found productive. Numerous possible traps have not been tested and it is probable that during the next few years more discoveries will be made.

## Exploration Frontiers in Southwestern Wyoming and Northwestern Colorado

**JOHN F. PARTRIDGE, JR., constultant, Casper, Wyo.**

THAT portion of Wyoming lying southwest of the Gros Ventre-Wind River-Sweetwater uplift and west of the Rawlins-Sierra Madre uplift and that portion of Colorado north of the Uinta-Axial uplift is truly an exploration frontier. The three basins—Green River, Great Divide-Red Desert, Washakie—and the overthrust belt of western Wyoming comprise an area of some 25,000 sq. miles or 15,850,000 acres. This is 22.5 per cent of the area of Wyoming and 3 per cent of the area of Colorado. Practically every acre of this vast area is potential oil land as the basement complex is not exposed within these limits. Yet to date, despite extensive surface mapping, seismic surveys and almost complete lease coverage, there are only 5 known oil fields, 13 gas fields, and only 1 exploratory well per 230 sq. miles. Rocks of every age from Tertiary to Cambrian are present under all or part of this province and each rock unit is capable of yielding oil or gas. There are rapid facies changes across this area from the Wyoming shelf to the Cordilleran geosyncline. Structure in this area varies from simple to complex. There is complex folded and faulted rim structure, simple basin structure, basinal uplift structure, and the complex folds and overthrusts in the overthrust belt. Every ingredient for the accumulation of oil and gas is present. It remains for the oil industry to explore and exploit this frontier of the Rocky Mountain region.

## Powder River Basin: A Frontier

**W. E. WEST, JR., consultant, Casper, Wyo.**

ALTHOUGH oil has been produced from the Powder River basin since 1889, the basin is still a frontier. The margins are defined by oil fields with the interior parts comprising a vast, virtually unexplored territory. Oil and gas have been found in a variety of traps unexcelled in number by any other Rocky Mountain basin.

The basin is rather simple structurally, with such complexities as exist involving large-scale faulting. The stratigraphy is complicated by numerous north-south and east-west changes in lithology and time span. Cretaceous sediments have accounted for most of the oil produced to date. Jurassic and Pennsylvanian rocks are also important producers. Developments of the past several years have demonstrated that it takes remarkably little to trap oil and gas in this basin and exploration ideas have changed accordingly. Fault-trap production, as demonstrated in Sussex-West Sussex area, and stratigraphic accumulations such as South Glenrock and Clareton-Black Thunder fields, are typical of more recent discoveries creating great optimism for exploratory work to come.

Future exploration will involve continued geophysical work to search out structural anomalies, particularly in the interior Tertiary-covered portions of the basin. Subsurface work will become increasingly important and surface methods will suffer a gradual decrease in popularity.

Discoveries will come from both structural and stratigraphic traps, with the latter type becoming increasingly important as more well control is made available.

## South Glenrock, a Wyoming Stratigraphic Oil Field

**WILLIAM H. CURRY, JR., Far West Oil Co., Casper, Wyo.**

WYOMING, long the stronghold of anticlinal occurrence of petroleum, is now yielding to the stratigraphic trap. South Glenrock, a 1950 discovery on the southwestern margin of the Powder River basin, has developed a 50-million-barrel reservoir in Lower Cretaceous sands of the Dakota and Muddy zones, without the benefit of structure closure.

The term "Dakota" for the lower sand, fits current usage, but the sand is at a different stratigraphic level than other sands of the Wind River basin to the west, also called Dakota. Dakota oil at South Glenrock is trapped by a westward facies change on a large eastward plunging nose off the prominent anticlinal structure of Big Muddy oil field. Muddy oil is found in lenticular sands associated with prominent channeling at a point of unconformity, 100 ft. above the Dakota zone.

South Glenrock structurally is integrally related to the Big Muddy anticlinal oil field, but produces from different sands. The latter exhibit depositional evidence of being influenced by an ancestral structural feature which was a pre-Laramide incipient "high" at the locale of South Glenrock. This was offset from the younger Laramide anticline which afforded structural accumulation at Big Muddy.

A close study of older sedimentation in other Wyoming localities probably will point to an earlier structural history of local uplifts. The ancestral structures may often be offset from their more robust Laramide progeny.

## Exploration Frontiers in Mesozoic Sediments of the Four Corners Region

**LEALAND M. KNAPP, Superior Oil Co., Albuquerque, N. M.**

THE Four Corners region includes 40,000 sq. miles in New Mexico, Colorado, Utah, and Arizona and is underlain by Mesozoic sediments. Within this area, 21,000 sq. miles are underlain by sediments at depths favorable for oil or gas production in at least one horizon. The present development of oil and gas fields in this area was foreshadowed by shows of oil and gas in early wells and by seeps in outcrop areas. Much of the present significant production is associated with stratigraphic changes in the formations which produce.

The Triassic Shinarup conglomerate, the Jurassic Entrada sand, the uppermost Jurassic Morrison (?) sand, the Upper Cretaceous Dakota-Graneros sands, and many other Upper Cretaceous sands intertonguing with the Mancos and Lewis shales have a record of oil and gas shows which has not been fully exploited in 90 per cent of the favorable area.

Exploration frontiers associated with sedimentation exists as overlooked variations in deposition, development and permeability of the Mesozoic sands. Frontiers associated with structure exists with possibility of fault traps, permeability traps, and hydrodynamic traps on low plunging folds with no apparent surface closure. Closure may exist on these folds in pre-Cretaceous sediments.

The known lithologic variations of the many possible reservoir beds, when combined with known regional structural anomalies, point to many areas of possible production in the sands with a proven record of shows.

# BOOKS

TABLES OF CIRCULAR AND HYPERBOLIC SINES AND COSINES FOR RADIAN ARGUMENTS. Published by National Bureau of Standards and for sales by Superintendent of Documents, U. S. Government Printing Office. 407 pp. $3.

This volume is a reissue of Mathematical Table 3, and is published to meet the continuing demand from scientists and engineers. The functions dealt with are of fundamental importance in pure and applied mathematics. The interval of the argument and the use of radian measure should prove of particular convenience to the user. Specifically these tables contain sin x, cos x, sinh x and cosh x, x = 0 (0.0001) 1.9999, 9D; sinh x and cosh x, x = 0 (0.1) 10, 9D; a conversion table of degrees, minutes, seconds ⟷ radians and a table of multiples of $\pi/2$.

DRY HOLE MAP OF NEVADA. Published by Petroleum Information, Continental Oil Building, Denver. $10.

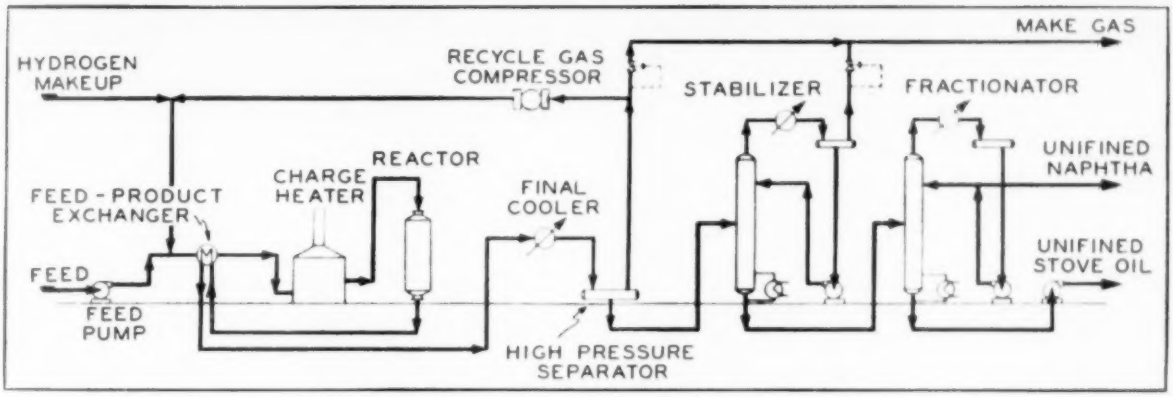
The map's scale is 1:500,000. All dry holes drilled in the state of Nevada are indicated on the map by name and total depth. Ranges and townships are shown as are counties and principal towns and cities.

STONEWALL COUNTY OILMANAC. Published by Five Star Oil Report, Inc., Box 331, Houston. 145 pp. $15.

This is the fifth in a series of worth-while reference books on oil and gas resources of the individual counties in Texas. The volume covers all producing fields in Stonewall County and includes details as to structure, producing zones, formations penetrated, structural cross-sections, and production data. In addition, the case histories of the fields include accurate structural maps. The data are presented in a compact and readily understood form. The book will be of interest to geologists, engineers, and drilling contractors because of the current activity in the area.

RESUME ROCKY MOUNTAIN OIL AND GAS OPERATIONS FOR 1953. Petroleum Information, Denver, Casper, Billings, Bismarck. $10. Book in three sections.

This annual review is designed both as an immediate recapitulation of the year covered, and as an annually revised reference volume. Development during 1953 is completely covered in concise fashion. All the wells drilled in the region during 1953 are listed. Discoveries are listed, with a discovery-well report on each successful wildcat in a separate section. A portion of the log is reproduced for each discovery. Statistical tables, graphs, and charts, many of them in two colors, offer a quick reference on every phase of industry operations in the Rockies. A map of the entire region showing 1953 discoveries in red is included.




SCHEMATIC FLOW DIAGRAM of the Unifining process. Fig. 1.

# UNIFINING . . . A New Petroleum Process

by H. W. Grote,* C. H. Watkins,* H. F. Poll,† and G. W. Hendricks†

FIRST COMMERCIAL INSTALLATION of the Unifining process is that of United Refining Co. of Warren, Pa. Fig. 2.

## . . . which shows particularly rapid payout where hydrogen from a catalytic reformer may be available within plant

UNIFINING is a new refining process which permits economic improvement of product quality of a variety of refinery stocks. This improvement is obtained by hydrogenation over catalysts containing cobalt and molybdenum, resulting in the nearly complete removal of sulfur, nitrogen, and metals.

In addition, when applied to cracked distillates, olefins are saturated and oxygen compounds are decomposed. This results in greatly improved product stability.

**Hydrogen available . . .** The widespread installation of U.O.P. Platforming, and recently, other reforming processes, has made available to refiners tremendous quantities of low-cost byproduct hydrogen.

This cheap hydrogen has stimulated research work on various hydrorefining processes; among those active in the field have been Universal Oil Products Co. and Union Oil Co. of California. Results of research and development activities of these two organizations have been combined in the Unifining process and made available through a single licensing arrangement to the petroleum industry. One commercial unit is now in operation and several more will be brought on stream before the end of this year.

The new technique differs from usual refining processes in that these improvements are obtained with little or no yield loss; volumetric recoveries above 100 per cent are common. The Unifining process is applicable to a wide variety of distillate stocks. These include various types of:

1. Gasolines, both straightrun and cracked.
2. Virgin and cracked middle distillates which can be converted to high-quality kerosines, stove oils, and diesel fuels.
3. Higher-boiling fractions, such as high-sulfur gas oils, heavy coker distillates, and catalytic cycle stocks.

### Chemistry of Unifining

The chemistry of Unifining is essentially that of selective hydrogenation. In removal of contaminants, it involves the controlled breaking of the molecular chain or ring at the point where

*Universal Oil Products Co., and †Union Oil Co. of California. Paper presented at annual W.P.R.A. meeting, San Antonio, March 29-31.

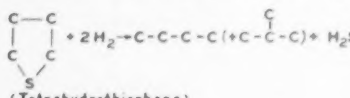
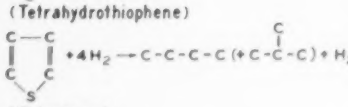
| | Reaction | $H_2$ Requirement CF/mole |
|---|---|---|
| 1. | $C-C-C-C-SH + H_2 \longrightarrow C-C-C-C + H_2S$ | 379 |
| 2. | $C-C-S-C-C + 2H_2 \longrightarrow 2C-C + 2H_2S$ | 758 |
| 3. | $C-C-S-S-C-C + 3H_2 \longrightarrow 2C-C + 2H_2S$ | 1,137 |
| 4. |  (Tetrahydrothiophene) | 758 |
| 5. |  (Thiophene) | 1,516 |

**Table 1—Typical Unifining reactions of sulfur compounds.**

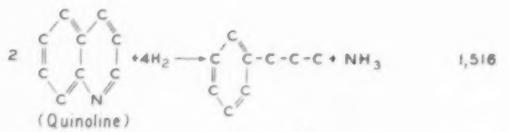
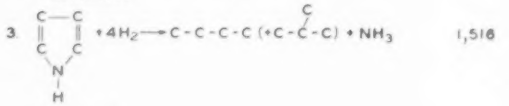
| | Reaction | $H_2$ Requirement CF/mole |
|---|---|---|
| 1. | (Pyridine) | 1,895 |
| 2. |  (Quinoline) | 1,516 |
| 3. |  (Pyrrole) | 1,516 |

**Table 2—Typical Unifining reactions of nitrogen compound.**

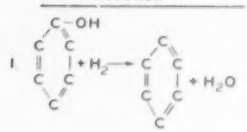
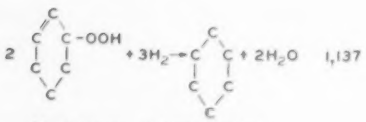
| | Reaction | $H_2$ Requirement CF/mole |
|---|---|---|
| 1. |  | 379 |
| 2. |  (Cyclohexene Hydroperoxide) | 1,137 |
| 3. | $C_7H_{13}OOH + 3H_2 \longrightarrow C_7H_{16} + 2H_2O$ (Heptene Hydroperoxide) | 1,137 |

**Table 3—Typical Unifining reactions of oxygen compounds.**

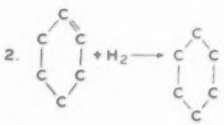
| | Reactions | $H_2$ Requirement CF/mole |
|---|---|---|
| 1. | $C=C-R + H_2 \longrightarrow C-C-R$ (+ isomers) | 379 |
| 2. |  | 379 |

**Table 4—Typical Unifining reactions of olefinic compounds.**

the sulfur, nitrogen, or oxygen atom occurs. This breaking is caused by the introduction of hydrogen with evolution of hydrogen sulfide, ammonia, or water. The resultant hydrocarbon reaction product usually remains either as one or more aliphatic hydrocarbons, or as an alkyl group on an aromatic or naphthenic hydrocarbon.

These hydrocarbon reaction products usually have larger liquid molecular volumes than do the parent sulfur, nitrogen, or oxygen containing reactants. Due to the fact that negligible cracking of carbon to carbon bonds occurs, the yields of liquids from most such Unifining operations are in excess of 100 volume per cent of the charging stock.

**Typical reactions . . .** Table 1 gives several typical reactions of sulfur compounds, and it can be seen that depending on the type of sulfur compound involved the hydrogen consumptions may vary from one to four moles of hydrogen per mole of reactant. Table 2 gives similar data for three types of nitrogen compounds, and it can be seen that the hydrogen requirements are again rather substantial per mole of nitrogen compound.

In this connection, it should be borne in mind that the nitrogen compounds usually occur in considerably lower concentrations than do sulfur compounds. Oxygen-containing compounds occur in many cracked stocks, the predominant types being those generally classed as phenols as well as various hydroperoxides. Table 3 gives typical reactions of such oxygen-containing compounds.

Of prime importance in the chemistry of Unifining are the various reactions of olefinic hydrocarbons. This importance is due to their high concentration in normal cracked distillates, resulting in substantial consumption of hydrogen in the Unifining of cracked stocks. Table 4 gives typical chemical reactions of olefinic materials during Unifining.

It can be seen that depending on the type of olefin, either aliphatic or naphthenic hydrocarbons may result. In this connection it is of interest to note that frequently in excess of 50 per cent of the olefins present in thermally cracked stocks are converted by Unifining to naphthenes indicating a rather surprising concentration of cyclic olefins in thermally cracked materials.

### The Process

Unifining is a particularly versatile refining tool. It may be applied to fractions of wide boiling ranges—from gasolines to heavy vacuum distillates. Such charging stocks may be of straightrun or cracked origin, of high sulfur content or low. The objectives of Unifining include:

1. Improvement in odor and color stability.
2. Pretreatment of catalytic reformer charge stocks.
3. Reduction in sulfur and nitrogen compounds.
4. Improvement in burning properties, cetane number, and susceptibility to catalytic cracking.

One particularly useful application of Unifining is the simultaneous preparation of catalytic reformer feed and high-grade stove oil by the processing of coker distillates. An equipment arrangement for such an operation is shown in Fig. 1. The feed is combined with hydrogen recycle gas, preheated by heat exchange with reactor products,

and heated to the required reactors inlet temperatures. On passing through the reactor the desired catalytic reactions are accomplished and, depending on the specific application, these may occur in either vapor-phase or mixed-phase conditions.

The reaction products, after heat exchange, are cooled and flow to a high-pressure separator. The hydrogen-rich gas from this separator is recycled back to the reactor; any excess over process requirements is vented to fuel. The high-pressure separator liquid flows to a stabilizer for removal of dissolved light gases and is shown in this figure as a conventional reflux stabilizer. In other specific applications this stabilizer may be replaced by a stripper, rectified absorber, or other comparable equipment. The stabilized product is then ready for fractionation as indicated in this flow diagram, or may be utilized directly.

The extensive laboratory development of the process was carried out in a high-pressure, continuous-flow bench-scale apparatus, followed by detailed investigation in fully integrated pilot-plant equipment.

### Plant Application

Based on the proven performance of the Unifining process in laboratory and pilot-plant units, a number of refiners have already adopted the Unifining process. United Refining Co., of Warren, Pa., announced the successful initial operation of the first commercial Unifining unit on February 19, 1954. Fig. 2 shows this unit which is designed to process 750 bbl. per stream day of many fractions, including kerosine and various mineral oils, producing highly stable, essentially sulfur-free, premium products.

Some of the other installations are Unifiner-Platformer combinations which will both allow economical reforming of low-grade stocks, and also provide for future flexibility in choice of charge stocks. In all, eight units are in operation, under construction, or in design, with a total design capacity of over 80,000 bbl. per day. The charge stocks to these units range in sulfur content up to 1.8 weight per cent, in nitrogen content up to 150 p.p.m., and, in certain cases, contain substantial amounts of metals.

Several of the Unifiner-Platformer combinations will charge a feed with a portion boiling above 400° F. which is converted in the Unifining process to a premium-quality component for No. 1 fuel or kerosine. These refiners will thus economically solve the problem of producing marketable products from low-quality, unstable fuel-oil fractions. A considerable number of additional Unifining units are in various stages of study, design, and engineering.

**Hydrogen consumption . . .** Chemical hydrogen consumption for Unifining amounts to 6 to 8 cu. ft. per bbl. for each unit of reduction in bromine number plus an additional 50 to 100 cu. ft. per bbl. for each unit of reduction in weight per cent sulfur. Other hydrogen consuming reactions are usually small for petroleum feeds. As a practical matter the actual plant consumption of hydrogen is always somewhat in excess of the chemical requirements.

The total hydrogen required depends not only on the chemical properties of the feed, including the specific types of sulfur compounds present, but also on the purity of the hydrogen supplied, and on the detailed process design of the particular Unifining plant. In designing, economic considerations set the efficiency of hydrogen utilization. Experience indicates that chemical consumption of hydrogen may range up to 90 per cent of that supplied with as little as 10 per cent being vented as bleed gas.

The Unifining reactions are exothermic and in some cases the charge heater is used only during startup periods. Unifining can employ a wide range of process conditions. The selection of optimum process conditions is based upon the nature of the feed stock, the desired quality of products, and on economic considerations. The majority of commercial Unifiners will operate at pressures below 1,000 psi. and at temperatures ranging up to 800° F.

The Unifining catalyst contains cobalt and molybdenum supported on alumina. It has specific activity for promoting the reactions desired in Unifining at processing conditions which suppress undesirable side reactions. It is relatively unaffected by those constituents of charging stocks, recycle gases, and regeneration gases, which are known poisons for many of the catalysts used in other refining processes. The catalyst is normally employed in the form of physically rugged cylindrical tablets.

It has been demonstrated to be extremely stable at temperatures far above those encountered in conventional catalytic refining processes; depending upon the stock processed and on the conditions employed, the catalyst remains active without regeneration for on-stream periods as long as a year or more. However, if and when regeneration is desirable it can be accomplished by simple combustion of the catalytic coke.

### Applications of Unifining

The Unifining process may be applied to distillate stocks of any boiling range.

**Naphtha stocks . . .** Unifining when applied to the processing of gasolines or naphthas may be used to accomplish several objectives. It can be used to desulfurize straightrun or certain cracked gasolines. Simple desulfurization of such stocks permits refiners to blend them into products meeting stringent stability and sulfur specifications providing the octane ratings of such blends are adequate.

This type of Unifining is also useful in the production of special premium-quality products such as solvent naphthas having rigid sulfur and odor limitations. Typical results of several Unifining operations on straightrun naphthas are given in Table 5. These data show that regardless of crude source or raw naphtha sulfur content, sweet products containing only 10 to 20 p.p.m. of total sulfur result from such processing.

In the catalytic cracking of high-sulfur gas oils, the raw catalytic gasoline usually contains sulfur compounds exceeding specification limits. In addition, while of adequate unleaded octane rating, such stocks frequently require some sulfur-removal treatment to improve the antiknock quality after addition of tetraethyl lead. In most cases the lower-boiling fractions of high-sulfur catalytically cracked gasoline can be economically treated by simple conventional means.

However, in a number of refineries,

TABLE 5—UNIFINING OF STRAIGHTRUN NAPHTHAS

| | Kuwait | | West Texas | | California | |
|---|---|---|---|---|---|---|
| Sample— | Charge | Product | Charge | Product | Charge | Product |
| Gravity, °A.P.I. | 54.3 | 54.4 | 58.9 | 60.6 | 47.1 | 47.2 |
| Distillation: | | | | | | |
| I.b.p., °F. | 260 | 260 | 153 | 131 | 272 | 278 |
| 10 per cent | 273 | 273 | 184 | 174 | 288 | 296 |
| 50 per cent | 298 | 298 | 230 | 226 | 305 | 306 |
| 90 per cent | 350 | 349 | 282 | 281 | 331 | 335 |
| End point, °F. | 378 | 380 | 330 | 326 | 361 | 370 |
| Sulfur, wt. per cent | 0.078 | 0.0011 | 0.15 | 0.0016 | 0.141 | 0.0022 |
| Bromine No. | | | 5.8 | 0.4 | 1.0 | 0.4 |
| Yield, vol. per cent | | 100.0 | | 100.4 | | 99.9 |
| Chemical hydrogen consumption, cu. ft. per bbl. | | 10-20 | | 50 | | 15 |

the heavy catalytic naphtha is of such a nature that sulfuric acid treating is required to produce a marketable product meeting both sulfur and stability specifications. Acid treatment of such stocks is both expensive to carry out, and results in substantial volumetric losses.

Table 6 gives data on the Unifining of such heavy catalytic naphtha in a mixture with heavy thermal naphtha which was carried out at rather mild conditions to obtain a low-sulfur, mercaptan-free, gum-stable motor-fuel blending stock. The sulfur and potential gum contents were reduced 83 and 93 per cent at a volumetric yield in excess of 101 per cent. No loss in leaded blending octane number was suffered.

**Charge pretreat . . .** Pretreatment of charge stocks prior to catalytic reforming is another of the many useful applications of Unifining. The catalytic reformer produces the hydrogen required by the Unifiner, and the Unifiner in turn utilizes a portion of the hydrogen to remove sulfur, nitrogen, and other undesirable components of the reformer charge. With normal straightrun naphthas being extensively upgraded by catalytic reforming, the refiners' attention has been directed to certain gasoline stocks which for one reason or another are not choice feeds for available catalytic reforming processes.

Among such materials are straightrun naphthas of abnormally high sulfur, nitrogen, and metals contents and a wide variety of thermally cracked naph-

**TABLE 6**
**Unifining California Mixed Thermal and Catalytic Heavy Naphthas Mild Operation**

| | Charge | Unifined product |
|---|---|---|
| Liquid yield ($C_4$+), vol. per cent of charge | | 100 |
| Gravity, °A.P.I. | 40.2 | 41.5 |
| A.S.T.M. distillation, °F.: | | |
| I.b.p. | 256 | 244 |
| 10 per cent | 284 | 281 |
| 50 per cent | 332 | 331 |
| 90 per cent | 384 | 382 |
| Maximum | 414 | 410 |
| Sulfur, wt. per cent | 0.52 | 0.09 |
| Bromine No. | 18.1 | 5.8 |
| Nitrogen, p.p.m. | 660 | 410 |
| Diolefins, wt. per cent | 0.9 | 0.1 |
| Phenols, wt. per cent | 0.3 | nil |
| Copper dish gum, mg. per 100 ml. | 42 | 2.8 |
| Blending octane numbers: | | |
| Research, clear | 87.0 | 81.0 |
| Research, +3.0 ml. TEL per gal. | 90.0 | 90.0 |
| Motor method, clear | 76.0 | 73.0 |
| Motor method, +3.0 ml. TEL per gal. | 79.5 | 81.0 |
| Hydrogen consumption (chemical), cu. ft. per bbl. of charge | 120 | |

**TABLE 7—UNIFINING CRACKED GASOLINES SEVERE OPERATION**

| | Oklahoma | | California mixed thermal and straight-run heavy naphtha | | |
|---|---|---|---|---|---|
| | Charge | Unifined product | Charge | Unifined product | 380° F. e.p. fraction of Unifined product |
| Gravity, °A.P.I. | 49.1 | 51.0 | 46.1 | 51.1 | 52.6 |
| A.S.T.M. distillation, °F.: | | | | | |
| I.b.p. | 215 | 214 | 221 | 196 | 195 |
| 10 per cent | 246 | 244 | 257 | 249 | 242 |
| 50 per cent | 300 | 298 | 313 | 310 | 296 |
| 90 per cent | 370 | 365 | 390 | 385 | 353 |
| Maximum | 408 | 436 | 440 | 446 | 379 |
| Sulfur, wt. per cent | 0.12 | 0.008 | 1.9 | 0.008 | 0.005 |
| Bromine No. | 67 | 3.5 | 20 | <1 | 0 |
| Nitrogen, p.p.m. | | | 130 | 10 | 5 |
| Arsenic, p.p.b. | 320 | <1 | | | |
| Liquid yield, vol. per cent | | 102.3 | | 101 | 90 |
| Chemical hydrogen consumption, cu. ft. per bbl. | 420 | | | 435 | |

**TABLE 8—UNIFINING OF 460° F. END-POINT DISTILLATE**

| | Unifiner feed | Unifiner products | | | |
|---|---|---|---|---|---|
| | | Total | Platformer charge | Stove-oil component | Platformate |
| Gravity, °A.P.I. | 50.7 | 50.6 | 52.2 | 42.4 | 46.7 |
| Distillation, °F.: | | | | | |
| I.b.p. | 246 | 271 | 261 | 431 | 126 |
| 10 per cent | 276 | 287 | 280 | 433 | 188 |
| 50 per cent | 323 | 331 | 313 | 440 | 291 |
| 90 per cent | 405 | 413 | 363 | 463 | 365 |
| End point | 460 | 463 | 405 | 502 | 450 |
| Sulfur, wt. per cent | 0.107 | 0.0011 | 0.0007 | 0.023 | |
| Bromine No. | 12.9 | 0.4 | 0.4 | 0.5 | |
| Basic nitrogen, p.p.m. | 25.9 | 1 | <1 | 2 | |
| Total nitrogen, p.p.m. | 43.1 | 1 | <1 | | |
| Arsenic, p.p.b. | 27 | <1 | | | |
| Saybolt color | | | | +20 | |
| Steam jet gum: | | | | | |
| As produced | | | | 1 | |
| After 4 months at 100° F. | | | | 1 | |
| F-1 octane, clear | | | | | 89.8 |
| F-1 octane, +3 cc. TEL per gal. | | | | | 98.2 |
| Yield, vol. per cent of Unifiner feed | 100 | 100.0 | 85.9 | 14.1 | |
| Yield, vol. per cent of Platformer charge | | | 100 | | 84.0 |
| Chemical hydrogen consumption, cu. ft. per bbl. | 90 | | | | |

**TABLE 9—UNIFINING STRAIGHTRUN MIDDLE DISTILLATES**

| | Wyoming diesel | | Montana stove oil | |
|---|---|---|---|---|
| | Charge | Unifined product | Charge | Unifined product |
| Gravity, °A.P.I. | 31.3 | 34.8 | 42.3 | 42.8 |
| A.S.T.M. distillation, °F.: | | | | |
| I.b.p. | 452 | 260 | 363 | 360 |
| 10 per cent | 523 | 492 | 399 | 390 |
| 50 per cent | 560 | 547 | 427 | 420 |
| 90 per cent | 603 | 596 | 474 | 474 |
| Maximum | 640 | 644 | 550 | 542 |
| Total sulfur, wt. per cent | 2.1 | 0.14 | 0.18 | 0.010 |
| Mercaptan sulfur, p.p.m. | | | 240 | 0.8 |
| Cetane No. | 46 | 52 | | |
| Color, Saybolt | | | +21 | +30 |
| Liquid yield ($C_5$+), vol. per cent of charge | | 101 | | 100 |
| Chemical hydrogen consumption, cu. ft. per bbl. | 140 | | 25 | |

thas and coker gasolines. Unifining provides the refiners with a tool for the economical processing of these marginal-quality stocks into ideal catalytic reformer feeds. With a Unifined feed stock the simplest type of catalytic reforming installation is all that is required. The Unifining results of Table 5 indicate that the products, in addition to being suitable for the preparation of specialties, are also prime feed stocks for catalytic reforming.

Such treatment is particularly desirable when catalytic reforming operations are carried out at high severities yielding products of 90-100 F-1 clear octane ratings. The benefits obtained by Unifining such straightrun feeds for catalytic reforming units are principally those of eliminating sulfur and metals from the naphthas. Nitrogen is also frequently present to an appreciable extent in straightrun naphthas ranging up to 15 p.p.m., and when thus encountered is readily removed by Unifining.

**Thermal stocks . . .** Thermally cracked stocks of various types are available to the industry in very large quantities. Cracked gasolines have been in the past the backbone of the refiners' gasoline blends, but, first with the extension of catalytic cracking facilities to all scales of refinery operations, and, second, with the widespread adoption of catalytic reforming processes, thermal gasolines are now of inadequate quality to be blended off in any but minor concentrations when producing premium fuels.

Unifining of thermally cracked gasolines allows the removal of sulfur, nitrogen, oxygen, and metals, while simultaneously saturating olefins and diolefins. By this treatment the undesirable materials are eliminated without destruction or loss of the parent hydrocarbons, which fact accounts for the extremely high liquid recoveries enjoyed with Unifining operations. Thus results a prime-quality feed for catalytic reform from what otherwise would be an uneconomic or, at best, an incremental charge stock whose tolerable concentration would be definitely limited.

Table 7 gives the results of Unifining of thermally cracked stocks. One is derived from Oklahoma crude and is of moderate sulfur content, but high in olefins and very high in arsenic content compared to straightrun feeds. The Unifined product is of low bromine number and sulfur content and the arsenic has been completely removed, while enjoying a liquid yield of 102 volume per cent.

The other data of this table show the application of Unifining for pretreatment of a high sulfur heavy cracked naphtha blend to prepare it for Platforming. After processing 61 bbl. of 440° F. e.p. charge naphtha per pound of catalyst in nonregeneration operation, the run was giving a product containing only 50 p.p.m. of sulfur and 5 p.p.m. of nitrogen on the 380° F. e.p. product fraction. In another similar test, 104 bbl. of feed per pound of catalyst was processed and at this catalyst service, the total liquid product contained only 150 p.p.m. sulfur.

The over-all hydrogen production balance for combined operation of a Uni-

**TABLE 10—UNIFINING CRACKED MIDDLE DISTILLATES**

| | Visbreaker distillate | | Catalytically cracked cycle oil | |
|---|---|---|---|---|
| | Charge | Product | Charge | Product |
| Gravity, °A.P.I. | 37.3 | 39.2 | 26.0 | 30.0 |
| Distillation, °F.: | | | | |
| I.b.p. | 365 | 350 | 451 | 301 |
| 10 per cent | 411 | 404 | 483 | 442 |
| 50 per cent | 450 | 446 | 531 | 518 |
| 90 per cent | 510 | 507 | 587 | 588 |
| End point | 563 | 567 | 618 | 624 |
| Sulfur, wt. per cent | 0.45 | 0.02 | 1.15 | 0.18 |
| Bromine No. | 45 | 3.0 | 19 | 8 |
| Aromatics + olefins, per cent | 58.9 | 29.1 | 50.4 | 48.9 |
| Yield, vol. per cent | | 101.3 | | 101.3 |
| Color, A.S.T.M. Union color: | | | | |
| Initially | 5 | L1.1 | 1 | 1 |
| After 6 months' storage | 5 | 1 | 4½ | 3 |
| Gum, steam jet, mg. per 100 ml.: | | | | |
| Initially | 10 | 1 | 7 | 2 |
| After 6 months' storage | 24 | 1 | 54 | 3 |
| Chemical hydrogen consumption, cu. ft. per bbl. | 330 | | 190 | |

**TABLE 11—UNIFINING HEAVY DISTILLATES**

| | Santa Maria coker distillate | | Heavy vacuum gas oil | | Catalytically cracked cycle oil | |
|---|---|---|---|---|---|---|
| | Charge | Unifined product | Charge | Unifined product | Charge | Unifined product |
| Gravity, °A.P.I. | 26.9 | 39.0 | 23.6 | 27.2 | 22.7 | 25.8 |
| A.S.T.M. distillation, °F.: | | | | | | |
| I.b.p. | 210 | 170 | 576 | 440 | 612 | 558 |
| 10 per cent | 318 | 285 | 674 | 600 | 631 | 612 |
| 50 per cent | 569 | 467 | 793 | 760 | 658 | 651 |
| 90 per cent | 870 | 722 | 879 | 870 | 693 | 696 |
| 95 per cent | 901 | 759 | | | | |
| Maximum | | | *902 | *894 | 740 | 748 |
| Sulfur, wt. per cent | 3.9 | 0.05 | 1.94 | 0.39 | 1.37 | 0.26 |
| Bromine No. | | 0.5 | | | 9 | 5 |
| Nitrogen, wt. per cent | 0.24 | 0.05 | | | | |
| Liquid yield, vol. per cent | | 102 | | 100.4 | | 100.0 |
| Chemical hydrogen consumption, cu. ft. per bbl. | 800 | | 170 | | 150 | |

*97 per cent over.

**TABLE 12—UNIFINING AND CATALYTIC CRACKING OF SAN JOAQUIN VALLEY COKER GAS OIL**

| | Total Unifiner charge | 410°-800° F. fractions— Unifiner charge | Unifiner product |
|---|---|---|---|
| Unifining: | | | |
| Liquid yield, vol. per cent of Unifiner charge | | 74 | 74 |
| Gravity, °A.P.I. | 15.5 | 17.7 | 22.6 |
| A.S.T.M. distillation, °F.: | | | |
| I.b.p. | 510 | | |
| 10 per cent | 624 | | |
| 50 per cent | 712 | | |
| 74 per cent | 800 | | |
| Sulfur, wt. per cent | 0.88 | 0.83 | 0.01 |
| Nitrogen, wt. per cent | 0.52 | 0.44 | 0.095 |
| Catalytic cracking of 410°-800° F. fractions: | | | |
| Conversion, vol. per cent of charge disappearance | | 36.5 | 40.0 |
| Cracked gasoline, vol. per cent of cracking charge | | 21.6 | 31.4 |
| Catalytic carbon, wt. per cent of cracking charge | | 7.6 | 4.7 |
| Gasoline-carbon ratio | | 2.8 | 6.7 |

fining unit with a catalytic reforming installation provides a useful excess of hydrogen. One of the most attractive means of using this hydrogen is to include in the Unifiner feed, cracked or straightrun material boiling above the gasoline range. By this technique, it is possible to separate from the Unifiner effluent a kerosine or diesel-fuel fraction of unusually good quality.

In Table 8 are given data from pilot-plant operations carried out while Unifining a blend of straightrun and coker distillates boiling up to 460° F. About 90 cu. ft. of hydrogen per barrel of Unifiner feed was required for sulfur and olefin reduction. This product from the Unifining operations was split into two fractions—a 400° F. e.p. Platformer charge stock and a 400° to 500° F. fuel-oil cut of excellent stability characteristics.

### Midbarrel Stocks

Unifining is an attractive means of producing premium kerosines, stove oils, diesel fuels, and other midbarrel distillates. The data of Table 9 indicate the application of this process to such fractions.

On Unifining a high-sulfur Wyoming diesel oil a six-point increase in cetane number was obtained with 93 per cent reduction in sulfur content. The small reduction in average boiling point results, not from the cracking of carbon-to-carbon bonds, but, from the conversion of high-molecular-weight sulfur compounds to lower-boiling hydrocarbons. The data on the processing of stove oil given in Table 9 illustrates the improvement in color, sulfur content, and odor that can be achieved by Unifining. The data indicate substantially complete removal of mercaptans, 95 per cent reduction in total sulfur content, and an improvement in color from +21 to +30 Saybolt without significant change in boiling range.

By Unifining cracked middle distillates, products are obtained having properties which approach those usually associated with virgin distillates from sweet crudes. In Table 10 are given data on the processing of a highly olefinic visbreaker distillate which was Unifined under conditions intended to give almost complete sulfur removal, and it can be seen that substantial improvements in both color and gum contents have been obtained. In addition measurements made on the charge and product after 6 months' dark storage at 100° F. indicate that the product has excellent stability characteristics.

### Unifining Heavy Distillates

The treatment of heavy distillates both cracked and straightrun to obtain catalytic cracking charge stocks of higher quality is another attractive application. Products from such operations can also be used in the preparation of premium-quality distillate fuel oils.

In Table 11 data are presented on the Unifining of a variety of heavy distillates. In the Unifining of a 26.9° A.P.I. gravity Santa Maria coker distillate containing 3.9 weight per cent sulfur, the liquid yield was in excess of 100 volume per cent with the reduction in sulfur being over 98 per cent. It can also be seen that removal of nitrogen was 79 per cent. In general, the removal of nitrogen from high-boiling distillates is more sensitive to changes in processing conditions than is desulfurization.

The remaining two feed stocks of Table 11 are of about the same gravity but of quite different origin—one being a virgin heavy vacuum gas oil, the other a catalytically cracked cycle oil. On processing these two stocks under conditions resulting in about 80 per cent desulfurization, both materials are improved to a degree which would permit their economic use as catalytic cracking feed components.

Further data on the upgrading of a low quality catalytic cracking feed stock are given in Table 12. The data show sulfur and nitrogen reductions by Unifining of approximately 99 and 78 per cent, respectively. Catalytic cracking runs were made on the 410°-800° F. fractions from both the Unifiner charge and product. Unifined fraction yielded 45 per cent more gasoline and 38 per cent less catalytic coke.

### Economics of Unifining

Unifining is a relatively low-cost catalytic process, from the standpoint of both capital investment and operating charges. Although cases have been evaluated which can justify the cost of installing a plant to produce hydrogen, Unifining shows particularly rapid payout where fuel-gas-value hydrogen from a catalytic reformer may be available within the refinery.

The hydrogen in excess of that required for pretreatment of catalytic reformer charge stocks may be utilized for sweetening and gum-stabilizing of cracked gasoline; for improving the product properties of midbarrel stocks, such as color, odor, stability, burning properties, cetane number, sulfur and nitrogen content; for the preparation of premium catalytic cracking charge stocks or for premium fuel oils.

The detailed economics vary considerably for different charge stocks and different product objectives.

This results from:

1. The wide potential range of process variables that may be employed.
2. The significant differences in plant design which result from considerations of flexibility and hydrogen utilization.
3. Values assigned to feeds and products.

**TABLE 13—UNIFINER COSTS**

| | Case 1* | Case 2† |
|---|---|---|
| Estimated plant cost | $750,000 | $425,000 |
| Operating costs, cents per bbl.: | | |
| Labor at $2.75 per hr. | 2.6 | 1.9 |
| Utilities: | | |
| Fuel at 15 cents per M.M.B.t.u. | | |
| Power at 0.8 cents per kw.-hr. | | |
| Steam at 30 cents per M. lb. | | |
| Water at 2 cents per M. gal. | | |
| Total | 2.8 | 2.0 |
| Catalyst | <2.0 | <2.0 |
| Hydrogen consumption at 15 cents per M.M.B.t.u. | 1.5 | 0.5 |
| Maintenance at 4 per cent, labor and materials | 1.8 | 1.0 |
| Insurance and property taxes at 2½ per cent | 1.2 | 0.7 |
| Total operating costs‡ | 11.9 | 8.1 |

*5,000 bbl. per stream day reactor charge (mixture of high-sulfur, cracked and straightrun naphthas, 210°-500° F.) stabilizer and splitter included to produce cat. ref. feed and fuel oil.

†5,000 bbl. per stream day of reactor charge (400°-650° F. straightrun) steam stripper included for diesel fuel product.

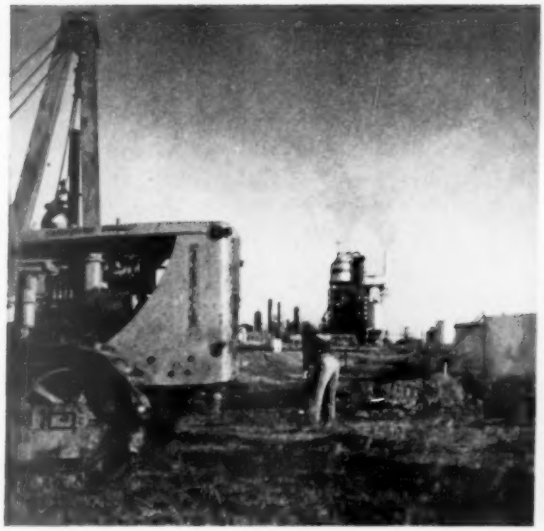
‡Excluding royalty, depreciation, administration, and overhead.

Over a wide range of Unifining applications it is estimated that erected plant costs (boundary limits) for a 5,000-bbl. per stream day Unifiner would vary from $75 to $175 per barrel of daily throughput.

The typically low capital and operating costs for two Unifining applications are illustrated in Table 13. They are both based on 5,000-bbl. per stream day Unifiners. Case 1 covers the processing of a wide-range, high-sulfur, cracked naphtha. The objective is to combine pretreatment of catalytic reformer charge together with production of high-quality stove oil or diesel-oil blending stock from a fraction otherwise suitable only for a residual fuel-oil cutter stock. Case 2 pertains to a much simpler type of installation for the upgrading of a poor-quality distillate into premium diesel fuel.

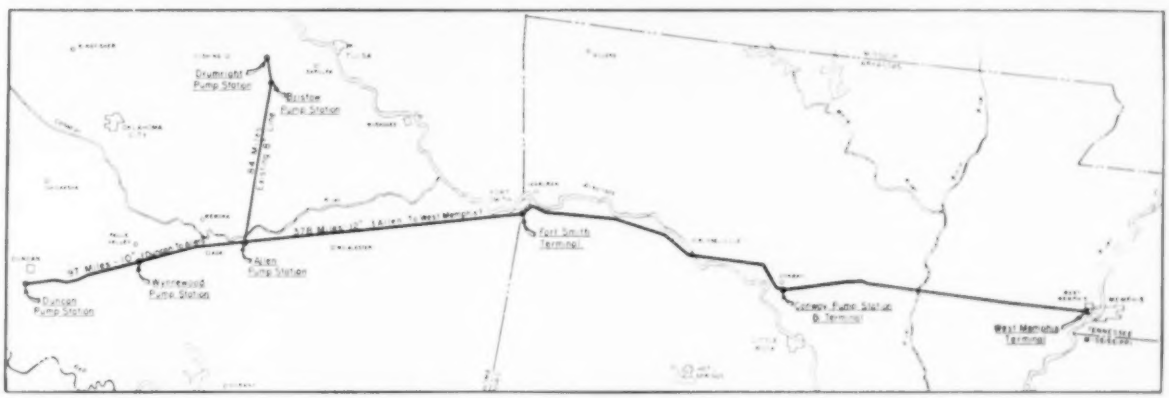
### Acknowledgment

The authors gratefully acknowledge the efforts of the technical staffs of Union Oil Co. of California and Universal Oil Products Co. whose work contributed to the content and preparation of this paper.



LAYING FIRST JOINT at Sunray Oil Corp.'s Duncan refinery.

TYING IN 10-in. pipe in wet ditch at Highway 7, near Velma, Okla.




Route of Oklahoma Mississippi River Products line from Duncan, Okla., to West Memphis, Ark.

NEW PRODUCTS PIPELINE TO MISSISSIPPI RIVER

# Oklahoma Refiners to Tap New Markets

## *Oklahoma Mississippi artery scheduled for June completion*

**by Paul Reed**
**Pipeline Editor**

FOR Oklahoma refiners a large market area will be opened to the eastward by Oklahoma Mississippi Products Line, Inc.'s, 470-mile common carrier Duncan, Okla.-West Memphis, Ark., system, to be completed in June 1954.

Cost of the project will be $20,000,000 to $25,000,000, depending on the amount of tankage to be installed. Sunray Oil Corp. has 50 per cent stock interest in the new pipeline company.

The lower cost of pipeline transportation in comparison with that of railroads, combined with low-cost river barging, will give Oklahoma refiners access to a trade territory consuming 734,000 bbl. of products per day. Initial capacity of the line will be 35,000 bbl. daily.

The new line will make it feasible for Sunray Oil Corp. and other refiners to ship products to any point on the Mississippi River, also to points up the Ohio River. Important Mississippi River ports to be reached are Memphis and Cairo, Ill. On the Ohio River, Evansville, Ind., Paducah and Louisville, Ky., will be accessible.

Along the route of the line, large consuming areas at Conway and Fort Smith, Ark., will be served which are not now reached by products lines.

**Timely project . . .** The timeliness of the project has been emphasized by

**ELECTRICAL DETECTION** located 142 underground lines crossing route in 20 miles between Duncan and Sholem Alechem field, Oklahoma.

**SIX BELL-HOLE WELDERS** running three hot passes simultaneously in 1½ minutes at the end of the day for River Construction Corp.

Oklahoma Mississippi officers who point to increase in Oklahoma refinery capacity beyond local demand and beyond the capacity of products pipelines for northward movement. The Oklahoma Mississippi River system will be the first products pipeline to go directly eastward.

Sunray will deliver products in the line at its Duncan and Allen refineries. The system will be available for shipments of other companies from Central and southern Oklahoma.

Deliveries into the new line can also be made through the 85-mile, 8-in. Drumright-Allen products line which has been recently acquired for $2,000,000 from Sunray Pipe Line Co. which owned 90 per cent and Wilcox Oil Corp. which owned 10 per cent. This line had been shipping to Great Lakes Pipe Line Co. connections. The Drumright-Allen system has pump stations at Allen, Bearden, and Bristow and 492,000-bbl. tankage.

Initial throughput of the system will be 75 per cent gasoline and 25 per cent middle distillates—No. 1 and No. 2 distillates.

Line fill will be 372,300 bbl. Tankage of the system will have total capacity of 1,934,500 bbl.

**Stations . . .** Pump stations and receiving terminals on the new line will be at Drumright, Bristow, Duncan, Wynnewood, and Allen, Okla. There will be a delivery terminal at Fort Smith and a delivery terminal and pump station at Conway, Ark. In the future, capacity can be increased by additional pump stations along the line. A large river terminal for barge, rail, and truck movements will be installed at a 110-acre site at West Memphis, Ark.

Stations will be equipped with 900-hp. Cooper-Bessemer gas diesel engines, each driving a four-stage Bingham centrifugal pump. There will be two units at Duncan, one at Wynnewood, two at Allen, and one at Conway. At Allen the units will operate in conjunction with an existing 900-hp. Alco engine-driven unit.

**Officers . . .** Officers of Oklahoma Mississippi River are: J. L. Shakely, president, who retired last year as president of Jones & Laughlin Supply Co.; J. R. Ellis, vice president and general manager; S. Price Gray, treasurer, and Burns H. Errebo, secretary.

Directors, in addition to Shakely and Ellis, are:

Paul E. Taliaferro, H. O. Harder, and L. W. Bennett, who are officers of Sunray Oil Corp. Other directors are Lloyd S. Gilmour, senior partner, and William G. McKnight, Jr., partner, both of Eastman, Dillon & Co., New York.

Engineering and construction management of the system has been contracted by Ford, Bacon & Davis Construction Corp. Engineering is under D. X. Ellett, chief engineer.

Construction of the project is supervised for Ford, Bacon & Davis by Fred C. Culpepper, Jr., project manager, Fort Smith, Ark.; R. F. Holt, division engineer, Ada, Okla., and A. W. Hart, Jr., field engineer.

### High Points of Line Construction

Construction of the project, the first eastward products pipeline system from Oklahoma, has been in progress since early November and will continue to the end of June.

Pipe for the line is seamless with ¼-in. wall. The 97 miles from Duncan to Allen is Jones & Laughlin 10-in. diameter. The 373 miles from Allen to West Memphis is National Tube 12-in.

Right-of-way is cut 40 ft. wide. The ditch is 22 in. wide for 10-in. and 24 in. wide for 12-in., and it is dug deep enough for 30-in. cover.

Protection for the pipe is provided by coal-tar coating, wrapped with glass mat and asbestos felt.

Every 10,000 ft. two pigs are run to insure that the pipe is clean.

All the submerged river crossings were completed in December with 5 ft. of cover at the Arkansas, Poteau, White, and St. Francis rivers.

### Contractors

Rivers Construction Corp. is now building 398 miles of 10 and 12-in. from Duncan to the White River in Arkansas.

Williams Brothers Co. laid 72 miles of 12-in. from the White River to West Memphis in November and December.

Each of the firms constructed the river crossings in its section.

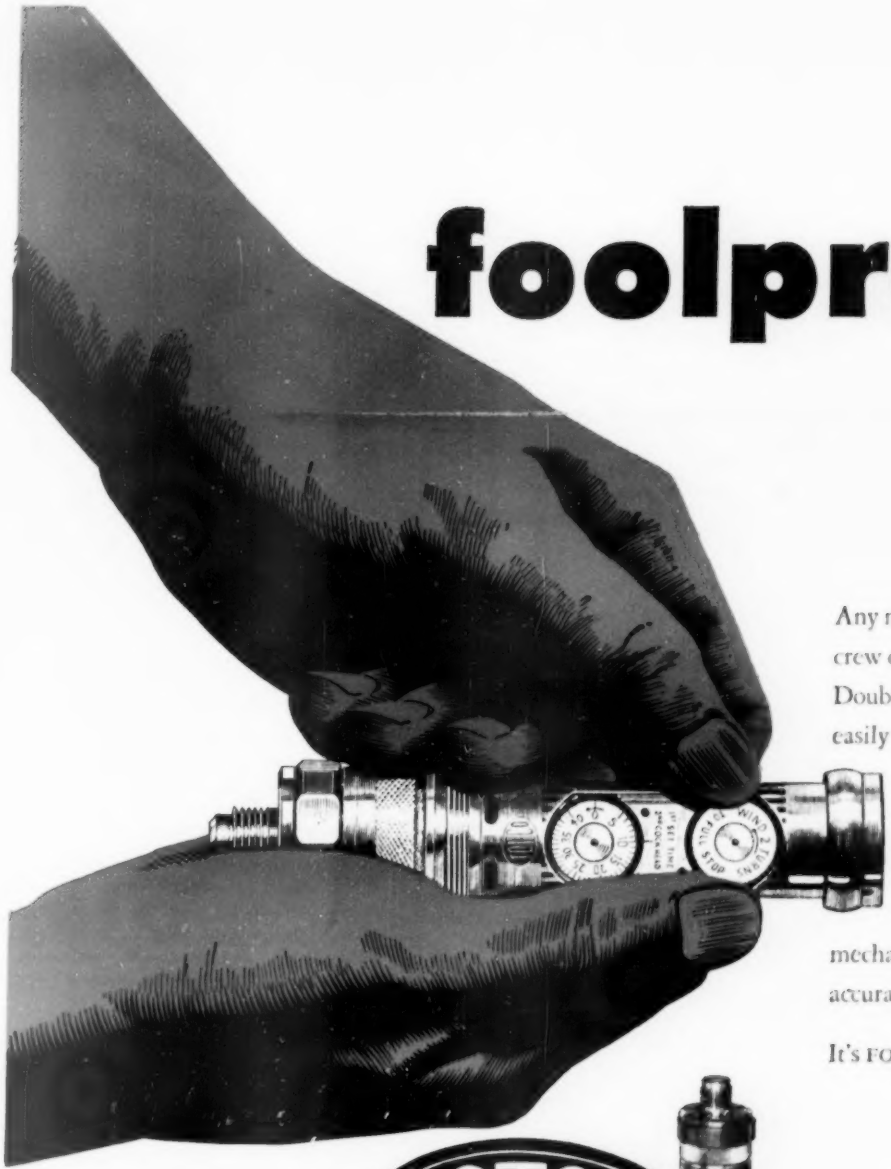
### River Construction Corp.

Pipe laying for the River Construction Corp. 398-mile section started with first spread to go in the field at Sunray Village south of Duncan in February.

Two more spreads started later making a total of three spreads now at work on the River company contract.

Pipe laying for the 90-mile, 12-in.

# foolproof



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PREPARING for tie-in weld with external-lineup clamp.

LINING UP JOINT for the pipe gang.

line in the western section of the project has been going ahead at a fast rate.

Between 10 a.m. February 11 and the end of February 15, 38,000 ft. was welded. Pipe-gang output has been as high as 12,000 ft. in a day. It is expected that, over good terrain, pipe will be laid consistently at 10,000 ft. per day.

**Welding . . .** At the pipe gang, pipe is lined up with internal lineup clamp. Two welders run the stringer bead.

To insure that the stringer bead is adequately reinforced to withstand the strain of contraction from cold at night, a hot pass has been run at the uncompleted welds at the end of the day. This is done on the pipe between the firing line and the pipe gang.

For such rapid hot passing at the end of the day, three welding-machine sleds have been tied together and pulled along by a tractor. The welding inspector calls this combination of equipment the "camel train." The three sleds, each mounting two 200-amp. welding machines, serves six welders running hot passes simultaneously at three welds in 1½ minutes.

The camel-train hot passing catches up with the pipe gang before quitting for the day.

Welding is done by 11 to 13 welders including two stringer-bead welders, a utility welder, and a tiein welder, plus seven to nine bell-hole welders.

Approximately 10 per cent of the welds are radiographed.

Right-of-way gang with dozer has been working 40 miles ahead of the pipe gang. The brush gang has been 55 miles ahead.

**Ditching . . .** Two ditching machines have been working 6 miles ahead of the pipe gang. One machine operates with two shifts per day while the other one operates with one shift. In rocky ground, trenching is done by three backhoes, a dragline, and a clam shell. Drilling is done by jack hammers.

**Pipe protection . . .** Primer is heated by exhaust from the engine of the cleaning and priming unit passing through the tank according to a recent practice which is being widely used in pipeline construction.

Lowering in is done with two tractors. The backfilling unit has a bucket which has been specially designed by the contractor.

The Washita River crossing is being laid overhead on an existing bridge supporting 4 and 6-in. lines. The towers of the bridge will be reinforced for carrying the Oklahoma Mississippi River line.

Spread No. 1, Wynnewood, Okla., field office is under Jimmy Reed, superintendent.

Spread No. 2, Paris, Ark., field office is under Red Tatum, superintendent.

Spread No. 3, Conway, Ark., field office under F. O. Traweek, superintendent.

A total of 242 miles had been welded by March 26 by River Construction Corp. This includes 93 miles between the Oklahoma-Arkansas state line and the White River in Arkansas plus 76 miles between Duncan and Allen, Okla. Construction was in progress at the station sites at Duncan, Wynnewood, Allen, Drumright, and Conway, and at the terminal sites at Fort Worth and West Memphis.

### Williams Brothers Co.

Laying of Williams Brothers Co.'s 72-mile section was prolonged by unseasonably rainy weather when the work was being done through November and December 1953.

Wet ground meant hard going in the White River bottoms when the job started and in the extensive rice fields at the eastern end toward the Mississippi River. Frequently it was necessary to push the pipe in ditches filled with water.

Sections of pipe pushed in this way were several hundred feet to 4,500 ft. long. Such operations were handled in the way which is familiar in the marshes of the Gulf Coast. Joints are added one at a time to the section floating in the water. After the welding of each joint, the pipe is pushed by a boom tractor. The forward end may be guided by a cable winched ahead.

In spite of difficulties, pipe was laid at an average rate of 4,500 ft. per day. Where terrain was favorable, the 12-in. pipe was laid as fast as 10,000 to 12,000 ft. per day.

Pipe was cradled into the ditch directly behind the coating and wrapping machine.

Trenching for the submerged crossings at the White River and the St. Francis River was accomplished by suction dredge procured locally and the contractor's clams.

The entire Williams Brothers 72-mile, 12-in. section was laid by one spread supervised by Marvin Jones, superintendent.

# Pipeline Patrol

## . . . Report on Construction

## Out With the Old . . .

DAMAGED section of pipe being removed from gas line supplying the Cabot Carbon Co. plant near Kermit, in West Texas. Internal corrosion had made this 18-in. line unserviceable and had necessitated the complete reconditioning.

After the worst sections of line had been replaced the entire line was cleaned and internally coated with plastic. This was the first successful attempt to coat a pipeline of such large diameter.

The plastic lining was applied by pushing a liquid plastic slug through the line between two scraper-type plugs, using air pressure to drive the slug.

Contractor on this job was Internal Pipeline Maintenance Co., of Odessa, Tex.

## Under Way, Contracted, and Planned . . .

PIPELINE activity as reported below by The Oil and Gas Journal is compiled from information received from pipeline companies and contracting firms.

These projects include those planned, proposed, under way, and contracted. Uncontracted projects are indicated by a • preceding the company name.

### Crude-Oil Pipelines

• **California - Oregon Pipe Line System**—103 miles 6-in., proposed, Crescent City, Calif., to Medford, Ore.

• **Cities Service Pipe Line Co.**—60 miles, 12-in., Sour Lake, Tex., to Houston, Tex. O. R. Burden Const. Co. Completion set for June 1954.

• **Magnolia Pipe Line Co.**—208-mile, 20-in. crude line planned from Corsicana to Magnolia's refinery at Beaumont, Tex. Work expected to start during second quarter of 1954 with completion set for 6 months. The line will cross the Trinity River 10 miles south of Oakwood and will pass near Crockett, Livingston, and Sour Lake. H. B. Zachry, Cont.

• **NNCW Pipeline Co.**—127-mile line, proposed, from Weston County, Wyoming to Casper. 108 miles of 10-in. and 19 miles of 8-in. Est. Cost: $3,503,000.

• **Orchard Pipe Line Co.**—45-miles, 8-in., proposed to transport crude from Masters field in Logan County, Colorado, to point 4 miles northwest of Orchard. Estimated cost: $811,250.

• **Pawnee Pipe Line Co.**—35 miles of 10, 8, and 6-in. line approved from Adena field in Colorado to Merino, Colo.

**Phillips Pipe Line Co.**—40 miles of 4 and 6-in. gathering lines under construction in Roberts County, Texas. Brodie Construction Co. is doing the work and expects to finish in April.

**Plains Pipe Line Co.**—25 miles of 8-in. in South Clareton area and more than 100 miles of 4-in. gathering lines are under way and slated for completion by April 15.

• **Progress Pacific Pipeline Co.**—1,100 miles, 24-in., planned, Odessa, Tex., to Los Angeles, Harbor, Calif.

• **Roosevelt Oil & Refining Corp.**—22 miles, 4 and 6-in., planned St. Helen to Norwich, Mich.

• **Sinclair Pipe Line Co.**—20 miles, 12-16-in., planned, Monee to Blue Island, Ill. Completion date 4-54.

• **Sioux Pipe Line System.**—Under study by Shell Pipe Line Corp. for group of 12 Williston basin producers. Length of line,

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pipe size, and terminal point pending final report by Shell.

• **Union Oil Co. of California.**—Planning construction of a 60-mile crude line from its Clara Valley field to its Wilmington refinery. Line is expected to be completed by late this year. Size not yet determined.

• **West Coast Pipeline Co.**—960 miles, 24-26-in., planned. Wink, Tex., to Norwalk, Calif. $106,000,000.

### Products Pipelines

**American Pipe Line Co.**—Line planned from Gulf Coast area to New York City area.

**Badger Pipe Line Co.**—215 miles, 8-10-12-in., begin Spring '54, East Chicago, Ind., to Madison, Wis. (Joint project of Cities Service Oil Co., Sinclair Pipe Line Co., Pure Oil Co., and The Texas Co.)

• **H. W. Bass & Sons, Inc.**—152 miles, 4-6-in., proposed. Duval and Live Oak counties, Texas, to Corpus Christi, Tex.

**Frontier Ref. Co.**—215 miles, 6-in., planned, Cheyenne, Wyo., to North Platte, Neb.

**Great Lakes Pipe Line Co.**—Under way extension 130 miles, 8-in., Nebraska City to Grand Island, Neb. R. H. Fulton Const. Co.

150-miles, 8-in. to run from Iowa City, Iowa to Prophetstown, Ill., and to tie in to the Badger system there.

**Harbor Products Systems**—86 miles, 16-in., under way, Woodbury Junction, Philadelphia to Linden, N. J. Construction Service Co. and H. C. Price Co. (Joint ownership of Sinclair Pipe Line Co., Gulf Refining Co., and Texas Pipe Line Co.) Completion date May 15.

• **International Pipe Line, Inc.**—132 miles, 8-in., proposed, Wrenshall to Minneapolis, Minn.

**Oklahoma Mississippi River Products Line,** Inc.—475 miles, 10 and 12-in., under way, Duncan, Okla., to West Memphis, Ark. Ford, Bacon & Davis Const. Corp.

Under way, White River to Allen, Okla. River Const. Co. Completion date 6-30-54.

Under way, Allen to Duncan, Okla. River Constr. Corp. Completion date 6-30-54.

• **Phillips Petroleum Co.**—54 miles, 6-in., planned, Goldsmith to Borger, Tex.

52 miles, 10-in., planned, Shell's Brookshire system to Sweeny, Tex.

**Shell Pipe Line Corp.**—65 miles of 12-in. products line from Baton Rouge, La., to Shell's Norco refinery. Houston Contracting Co. has contract and expects to start in April if weather and ground conditions are satisfactory.

• **Triangle Pipe Line Co.**—560 miles, proposed, Arkansas City, Ark., to Covington, Ky., and Nashville, Tenn.

**U. S. Gov't. Alaskan Products Pipe Line.**—600 miles, 8-in., under way, Haines northward through British Columbia and Yukon to Fairbanks, Alaska. Williams Bros., McLaughlin, Inc., and Marwell Const. Co. Completion date 9-55.

**Williston Basin Pipe Line Co.**—250 miles, 8-in., planned, Laurel-Billings, Mont., refineries to Glendive, Mont.

**Wolverine Pipe Line System**—200 miles, 14-in., under way, Chicago-Toledo-Detroit. (Joint ownership of Shell, Texas, and Cities Service.) Anderson Bros. and Midwestern Constructors, Inc. Completion date 1-54.

East Chicago, Ind., to Kalamazoo River. Midwestern Constructors, Inc.

**Yellowstone Pipe Line Co.**—(Continental Oil Co., Interstate Oil Pipe Line Co., Union Oil Co., and H. Earl Clack interest) 540 miles, 10-in., under way, Billings, Mont., to Spokane, Wash. 9-54.

Billings to Bozeman, Mont. Ross and Powers. Comp. July 1954.

Bozeman to Helena and on to Clinton, Mont. Associated Pipe Line Contractors, Inc. Completed.

Clinton to Perma, Mont. Associated Pipe Line Contractors, Inc.

Clinton to Perma, Mont. Eastern Pipe Line Fields Service Co.

Perma, Mont., to Murray, Idaho. Eastern Pipe Line Field Service Co.

Murray, Idaho to Spokane, Wash. Engrs. Limited Pipe Line Co. Total cost: $20,000,000.

### Natural-Gas Pipelines

• **American-Louisiana Pipe Line Co.**—1,121 miles of 30 and 22-in., 30-in., proposed, extends from North Tepetate, Acadia Parish, Louisiana, to near Detroit. The 22-in. starts near Payne, Ohio, extends to Bridgman, Mich. Estimated cost: $130,000,000.

• **Associated Natural Gas Co.**—88 miles, proposed, Missouri.

• **Atlantic Seaboard and Virginia Gas Transmission.**—116 miles, 26-in., proposed, loops along Cobb, W. Va., to near Baltimore, Md. Start May 1.

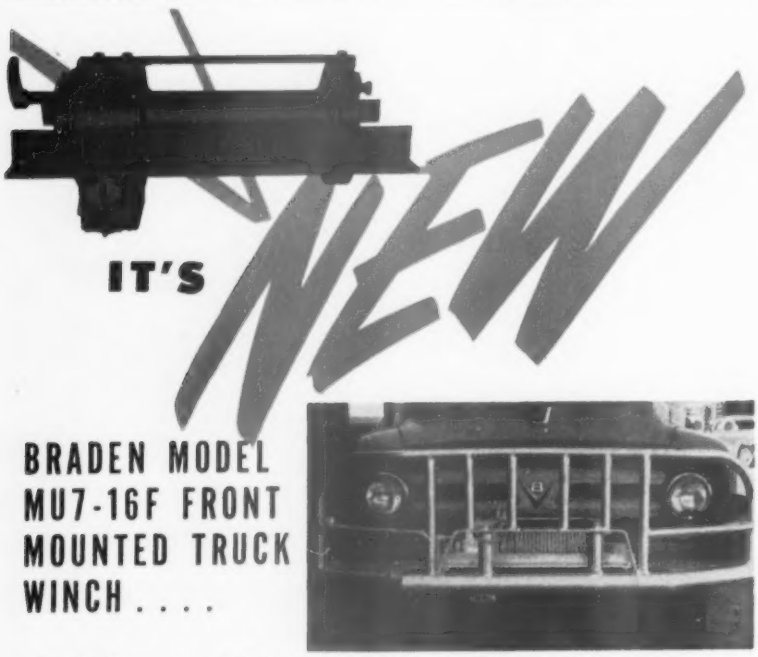
**Buzzards Bay Gas Co.**—28 miles, 8-in., under way, Hyannis, Mass., to Bourne Bridge, Mass. Hallen Co., Inc. Completion date 4-30-54.

• **Carolina Natural Gas Corp.**—185 miles, 2-12-in., proposed, lateral lines off Transcontinental in North and South Carolina.

**Chicago District Pipe Line Co.**—19 miles of 36 and 30-in., completed of 35 miles planned. Remainder, all 30-in., will be completed in 1954.

• **Cities Service Gas Co.**—24 miles of 26-in. proposed, to replace two existing 16-in. lines in Franklin and Johnson counties, Kansas.

Nine miles of 20-in. to replace existing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16-in. line in Cherokee and Jasper counties, Missouri.

• **City of Dalton, Ga.**—Proposes to build 39 miles of 8-in. from a point of interconnection with Southern Natural's Rome-Calhoun transmission line. Estimated cost: $2,940,000.

• **City of Fayette, Ala.**—20 miles, 5-in., proposed, Fayette, Ala., to Southern Natural's system in Tuscaloosa County, Ala.

**City of Dallas, Ga.**—56 miles of 8 and 4½-in., distribution system. Engineering & Const. Co. Start April 1, 1954.

• **Coast Counties Gas & Electric Co.**—40 miles, 3, 4, and 8-in., planned. Coast and Valley region, California.

• **Colorado Interstate Gas Co.**—365 miles, 22-in., proposed, Green River, Wyo., to Denver, Colo. 1954.

49 miles, 20-in., approved, Morton County, Kansas, to near Hooker, Okla. Estimated cost: $3,999,000.

**Colorado Interstate Gas Co.**—243 miles, 4 to 20-in., under way, Colorado, Oklahoma, Texas, and Kansas. Engineering Const. and Z. J. Graham.

• **Colorado-Western Pipe Line Co.**—454 miles of undetermined size pipe planned between Cortez in Montezuma County and Denver. Line would serve towns of Montrose, Gunnison, Salida, Fairplay and South Platte, Colo. Estimated cost: $30,000,000. Company also plans 254 miles of laterals to service Colorado cities not now receiving natural gas.

328-mile line, proposed, to run from a point in La Plata County in southwestern Colorado over the Continental Divide along the eastern slope to serve Pueblo, Colorado Springs, and Denver. Estimated cost: $21,600,000.

**El Paso Natural Gas Co.**—1,178 miles under way, Permian basin, New Mexico, Texas and Colorado. Spring '54.

**El Paso Natural Gas Co.**—771 miles, 30-in., under way, Plains, Tex., to Kingman, Ariz.

Section 1—Under way, Plains, Tex., to Corona, N. M. Oklahoma Const. Co.

Section 2—Under way, Corona to Suwanee, N. M. R. H. Fulton.

Section 3—Under way, Suwanee to Gallup, N. M. R. H. Fulton.

Section 4-5—Under way, edge to Navajo Reservation east to Flagstaff on to Kingman, Ariz. Western Pipe Line Const., Inc. Completion date 2-54.

Under way, across Navajo Reservation connecting sections 3, 4, and 5. El Paso Co crews.

Under way, Spraberry fields, El Paso Co crews.

• **El Paso Natural Gas Co.**—20 miles of 10¾-in. proposed from Warren Petroleum Corp.'s Saunders plant in Lea County, New Mexico, to connection with El Paso's existing 30-in. line in Lea County.

• **Fort Worth Basin Gas Co.**—Planned, Novice, through Brown and Comanche counties, Texas.

• **Glacier Gas Co.**—285 miles, 20-in., proposed, Kalispell, Mont., to Spokane, Wash.

120 miles, 16-in., proposed, Spokane to Hanford, Wash.

91 miles, 8⅝-in., proposed, Spokane to Lewiston, Idaho.

130 miles, 12¾-in., proposed, Spokane to International boundary at Trail, British Columbia.

**Gulf Interstate Gas Co.**—860 miles, 30-in., under way. Acadia Parish, La., to Boyd County, Ky. H. C. Price and Houston Contracting. 11-54.

Houston Contracting Co., Ltd., has completed 370 miles of its 500-mile contract from Rayne, La., to Kinkade, Tenn. Three spreads which have been working on the job are presently overhauling equipment and will not resume work until spring. Spread 1, headed by E. C. Norris, has completed 165 miles from

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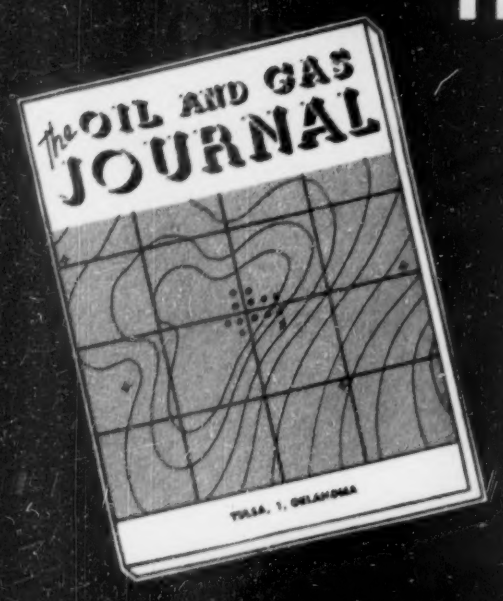
# REGIONAL

## OF TEXAS, OK

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Acknowledgments are made for the assistance of many individuals and co

## REGIONAL GRAVITY MAP OF TEXAS & OKLAHOMA

The structural interpretation of the geology of Texas and Oklahoma presented here is based upon gravity data. Purpose of the map is to provide a regional framework for closer interpretation of local gravitational effects and to advance possible new concepts of known geological structures. The map is contoured to 10 milligals or 100 gravity units except along the Gulf Coast where the interval is 5 milligals in order to show numerous salt domes in that area.

### LEGEND

- OROGENIC AXES
- AREAS OF INTERSECTION & FAULTING
- COMPRESSIVE FORCES
- MARINE
- SEA

S

# L GRAVITY MAP

## KLAHOMA, AND UNITED STATES

Printed as Supplement to Article by Lester Logue, Exploration Surveys, Inc., on "Gravity Anomalies of Texas, Oklahoma, and United States," and as Supplement to The Oil and Gas Journal, Vol. 52, No. 50. Copyright 1954 by Exploration Surveys, Inc., and The Oil and Gas Journal.

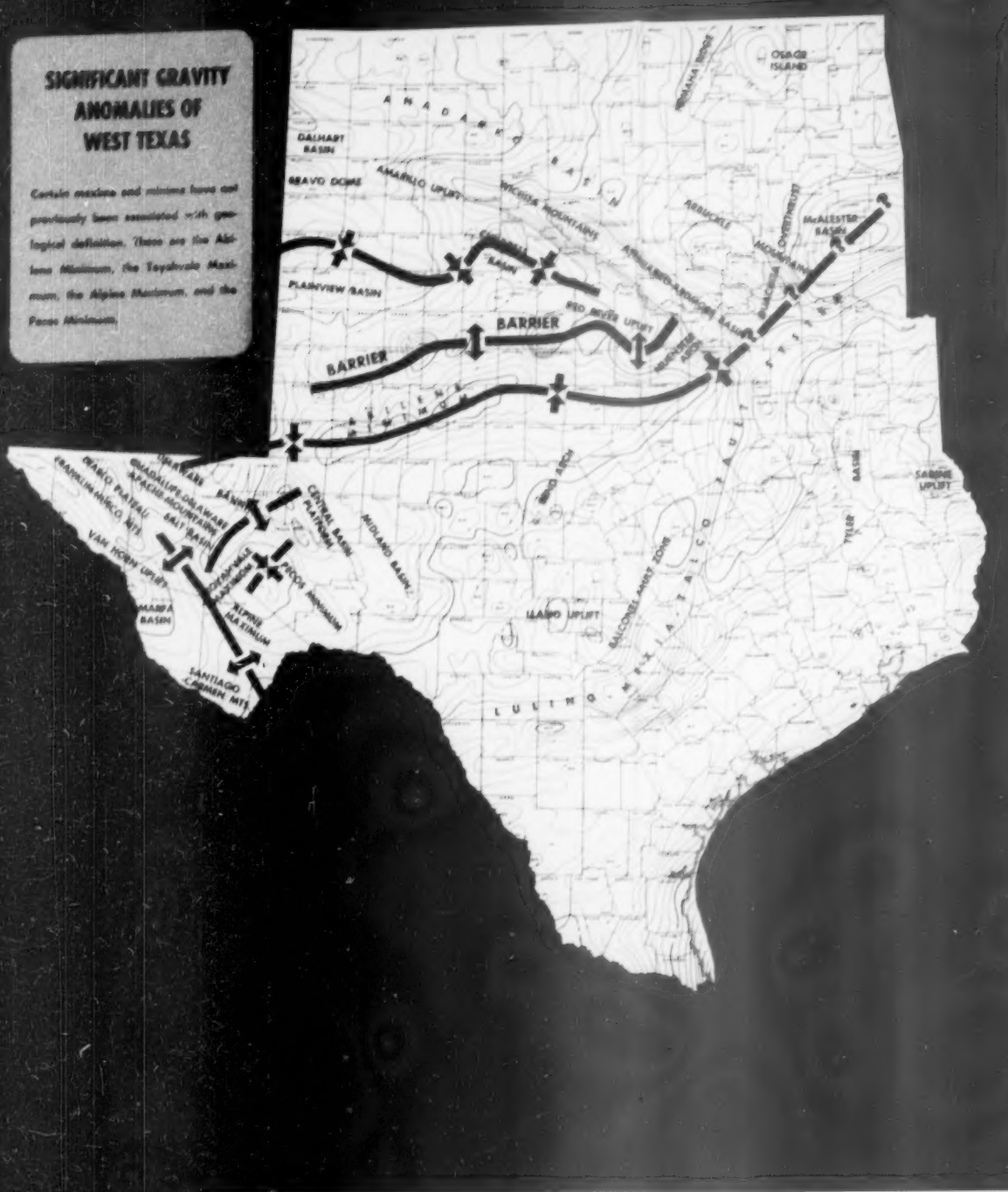
and companies in the compilation of these maps. The following deserve special recognition: Magnolia Petroleum Co., Sun Oil Co., Paul L. Lyons.

## SIGNIFICANT GRAVITY ANOMALIES OF WEST TEXAS

Certain maxima and minima have not previously been associated with geological deflection. These are the Abilene Maximum, the Toyahvale Maximum, the Alpine Maximum, and the Pecos Minimum.

## PRE-CRETACEOUS AND POST-JURIASSIC STRUCTURAL TRENDS

The structural alignment parallels a quinocent Llanoria. Presence of the northeast-southwest barrier probably accounts for the updip limit of the Eagle Mills formation.



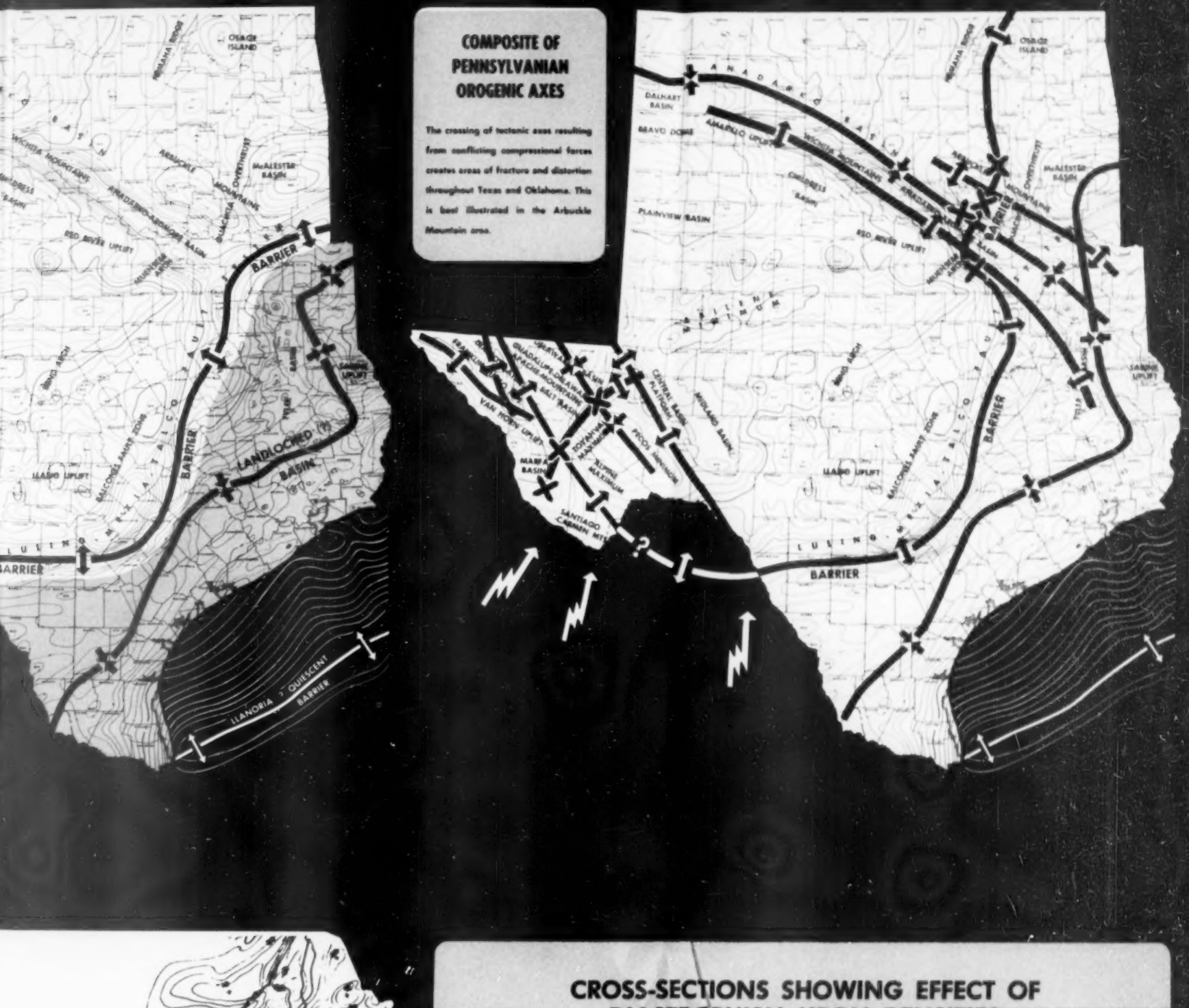
## GRAVITY ANOMALIES FOR THE UNITED STATES

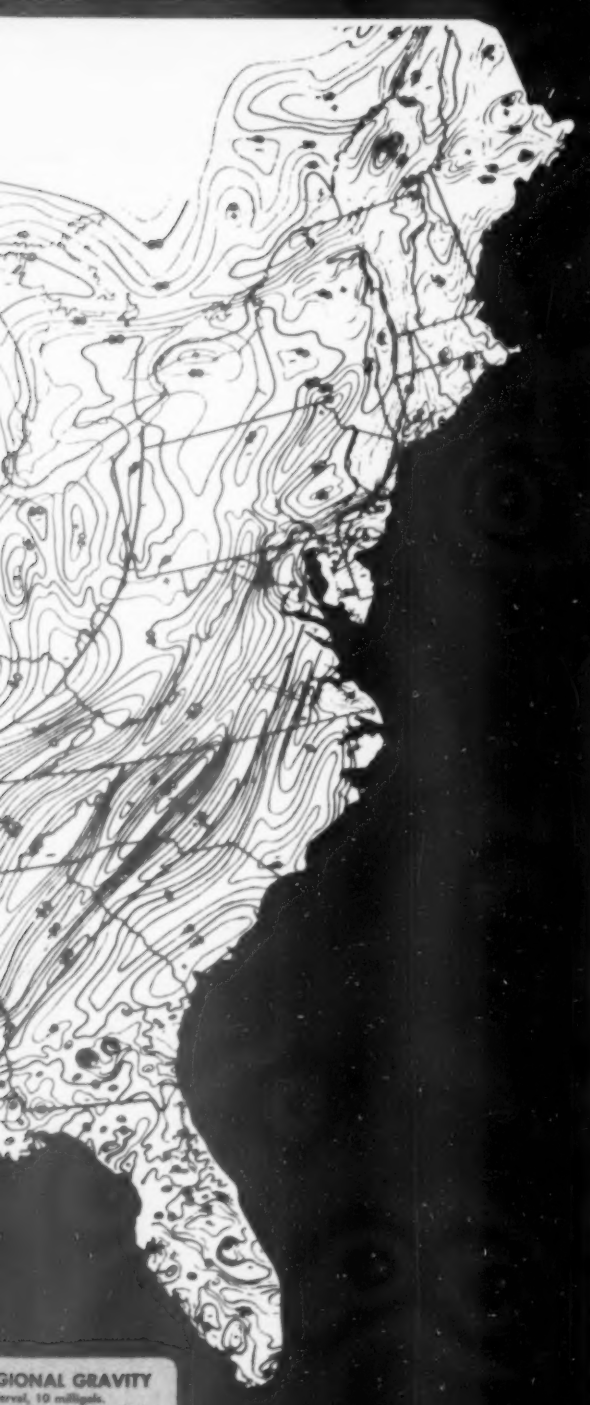
Regional gravity features of the United States are shown. Presence of Llanoria in the Gulf of Mexico and its apparent connection with Appalachia are indicated.

UNITED STATES - REGIONAL G
Bouguer anomaly—contour interval, 10 milli
(Courtesy Carter Oil Co. and published sou
Geological Society Digest, Vol. XVIII, 1950.)

## COMPOSITE OF PENNSYLVANIAN OROGENIC AXES

The crossing of tectonic axes resulting from conflicting compressional forces creates areas of fracture and distortion throughout Texas and Oklahoma. This is best illustrated in the Arbuckle Mountain area.

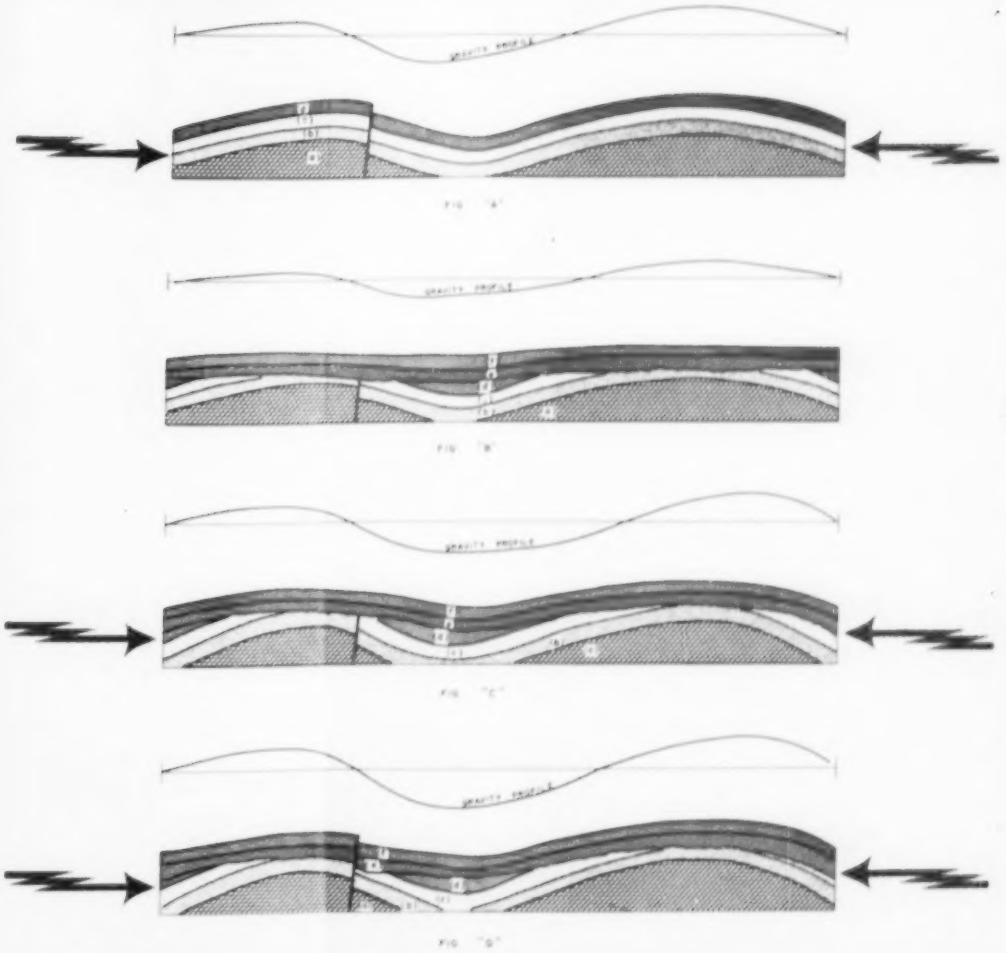


GIONAL GRAVITY
erval, 10 milligals.
published sources – Tulsa
XVIII, 1950.)

## CROSS-SECTIONS SHOWING EFFECT OF DIASTROPHISM UPON DENSITIES

In Fig. A, two simple anticlines are projected, one of which is faulted. Fig. B displays new deposition after erosion and truncation. In Fig. C, the old anticlines have been rejuvenated, leading to faults in younger beds. Fig. D shows the continued projection of the old fault through younger beds along the zone of weakness.



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the Mississippi River northward and it will resume work this spring.

Spread 2, headed by F. A. Silar, has completed 117 miles from the Ouachita River southward into the inception point of Rayne.

Spread 3, headed by M. L. Thompson, has completed 88 miles from the Ouachita River northward to the Mississippi River. It will begin work in the spring at the terminus of Kinkade, going south to join with Spread 1.

The remaining 360 miles is under contract to H. C. Price Co., Bartlesville, Okla. The firm has completed 279 miles and has 81 miles remaining which will be started in the spring. Five spreads, headed by G. A. Reutzel, R. L. Ezell, C. E. Shivel, C. R. Ice, and W. H. Olrich, have done the work. Price's contract covered the line between Gordonsburg, Tenn., and Catlettsburg, Ky.

**Under way, Rayne, La., to Kincade, Tenn.** Houston Contr. 370 miles laid. 130 miles left to be finished Spring of 1954.

Under way, Gordonsburg, Tenn., to Catlettsburg, Ky. 266 miles completed, 91 miles left.

230 miles, gathering lines, under way. Associated Pipe Line Contractors, Anderson Bros., Williams Bros.

329 miles, 12 to 24-in., proposed. Lateral off Acadia Parish, Louisiana, to Boyd County, Kentucky, line.

● **Home Gas Co.**—32 miles, 12-in., planned Breesport to Union Center, N. Y.

17 miles, 12-in., proposed, loops from Hancock to Sanford, N. M.

**Iroquois Gas Corp. and Tennessee Gas Transmission Co.**—Companies planning joint storage project to be known as Colden storage field in New York. The following delivery and gathering lines are planned:

17 miles, 16-in. delivery line.

62 miles, 12, 8, 6, and 4-in. gathering lines.

● **Iroquois Gas Corp.**—25 miles of 20-in. line proposed from Iroquois' Porterville station near Elma, N. Y., to Tonawanda, N. Y.

● **Kansas-Nebraska Natural Gas Co.**—Proposes to construct 41 miles of line to replace existing lines. Estimated cost: $922,000.

● **Lateral Gas Pipe Line Co.**—27 miles 4½ in., proposed, from Grant to Clarinda, Ia. Estimated cost: $267,200.

**Lone Star Gas Co.**—31 miles of 16-in. under way from Sulphur Springs, Hopkins County, to power plant near Johnstown, Red River County, Texas. Work being done by company forces.

Work will begin this month by company forces on 20 miles of 12-in. from Red Springs, Wood County, to 14-in. line connection in Smith County, Texas.

32 miles of 10¾-in. will start at Barnhart's gasoline plant in Reagan County and connect to applicant's 20-in. line in Upton County, Texas. Estimated cost $798,603.

● **Manufacturers Gas Light & Heat Co.**—40 miles, proposed, Allegheny, Washington and Beaver counties, Pennsylvania.

213 miles, 3 to 26-in., proposed, various points on system in Pennsylvania, West Virginia, and Ohio.

72 miles, 16-20-in., proposed, Doddridge, Wetzel and Marshall counties, West Virginia.

● **Michigan Consolidated Gas Co.**—25 miles, 12-in., proposed, from near Sparta to Muskegon, Mich.

● **Michigan-Wisconsin Pipe Line Co.**—251 miles, proposed, 24, 18, 12, 6, and 4-in. loops. Majority will be in Illinois.

**Missouri Central Gas Co.**—25 miles, 6-in., proposed, Moberly to Macon, Mo.

● **Missouri Public Service Co.**—136 miles, 8-10-in., proposed, New Franklin to Trenton, Mo.

24 miles, 10-in., Johnson County to Clinton, Mo.

● **Montana-Dakota Utilities Co.**—Proposes to build 56 miles of 2, 4, and 6-in. line from

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its 12-in. Cabin Creek-Bismarck line near Gladstone, N. D., to the towns of Lefor, Regent, New England, and Mott, N. D.

• **Natural Gas Producer, Inc.**—100 miles, 12-in., planned, Yenter pool to Denver, Colo.

• **New River Gas Co.**—50 miles, planned, Summers to Monroe counties, West Virginia, to Narrows and Dublin, W. Va.

• **North Dakota Gas Transmission Co.**—470-mile line from Tioga plant of Signal Oil & Gas Co. and Beaver Lodge field to Fargo and Grand Forks, N. D. Line will have 78 miles of 12-in., 215 miles of 10-in., 70 miles of 8-in., and 107 miles of 6-in. Estimated cost: $10,800,000.

• **Northern Indiana Fuel & Light Co.**—35 miles, 8-in., planned, Edgerton to Auburn, Ind.

• **Northern Natural Gas Co.**—Company planning 359 miles of lines for 1954; 200 miles will be main line, 139 miles will be branch lines, and 20 miles will be gathering lines. Pipe size and areas, not announced yet. Est. cost: $38,000,000.

• **Northwest Alabama Gas District**—40 miles, 9-in., proposed, Southern Natural's line through Windfield to Haleyville, Ala.

**Northwest Natural Gas Co.**—665 miles of unannounced size pipe to bring gas from Alberta, Canada, to the "Inland Empire" of northern Idaho and eastern Washington. Estimated cost: $36,000,000.

• **Ohio Fuel Gas Co.**—31 miles, 20-in., planned, Licking County to Richland County, Ohio.

22 miles, 16-in., planned, Dayton, Troy, Piqua, and Sidney, Ohio.

23 miles, 16-20-in., planned, Wellington to Elyria, Ohio; 16 miles, 20-in., planned, Benton Station to Crawford Station; 18 miles, 20-in., Crawford Station to near Columbus; 16 miles, 16-in., planned, Berlin to Sandusky, Ohio.

74 miles, 3 to 20-in., planned, Hocking, Knox, and Ashland counties, Ohio.

47 miles, 20-in., planned, Benton Township, Hocking County, to Columbus, Ohio.

61 miles, planned, northern and southwestern Ohio.

33 miles, 20-in., proposed, Jefferson to Seneca, Ohio.

69 miles, 20-24-in., proposed, lines to tiein Gulf Interstate line along various points in Lawrence, Jackson, Vinton, Hocking and Fairfield counties, Ohio.

**Pacific Gas & Electric Co.**—200 miles, 34-in., planned, paralleling Topock-Milpitas line. 107 miles contracted to Engineers Limited Pipe Line Co. L. E. Robertson is in charge of the spread handling work from Newberry to Danby and from Los Muertos Creek to Gilroy, Calif.

15 miles, 20-in., planned for completion in 1955 from Helm Tap to Helm Junction, Calif. Alex Robertson Co.

15 miles, 12-in., planned for completion in 1955. From Herndon to Madera, Calif. Company forces.

13 miles, 16-in., scheduled for completion in 1954. From Fairfield to Napa Wye, Calif. M.G.M. Construction Co.

30 miles, 10-in., scheduled for completion in 1954. From Corning field to Chico, Calif. Company forces.

19 miles, 16-in., from Wild Goose field to Yuba City, Calif. Scheduled for 1954 completion by company forces.

• **Pacific Northwest Pipeline Corp.**—1,466 miles, proposed, Ignacio, Colo., to Bellingham, Wash.

380 miles, proposed, laterals and spurs off main line to Pocatello, Idaho, to Yakima, Wash.

• **Pine Tree Natural Gas Co.**—204 miles of undetermined size pipe to run from the Boston area to Bangor, Me.

• **Shenandoah Gas Co.**—40 miles, 3-4-8-in.,


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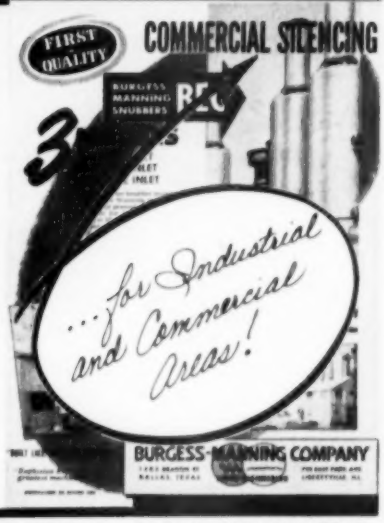


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proposed, Middleton, Va., to Martinsburg, W. Va. Est. cost: $1,470,000.

• **South Georgia Natural Gas Co.**—339 miles, 2-12-in., planned, Phoenix, Alta., to Tallahassee, Fla. (a) 12-in., Phoenix, Ala., to Albany, Ga., (b) 10-in., Albany, Ga., to Moultrie, Ga., (c) 8-in., Moultrie, Ga., to Tallahassee.

• **Southeast Alabama Gas District.**—150 miles, 10 and 8-in., planned, Phoenix City to Dothan, Ala. Engineering Const. Co. Start April 1, 1954.

• **Tennessee Gas Transmission Co.**—574 miles, 30-in., planned, Kinder, La., to Portland, Tenn.

63 miles, 26-in., planned, loops in Ohio and Pennsylvania.

45 miles, 20-in., proposed, Buffalo, N. Y., to the U.S.-Canadian border near St. Catherines.

243 miles 24-in., planned, Coudersport, Pa., eastward across Pennsylvania, New Jersey, and New York to point near Greenwich, Conn.

• **Texas Eastern Penn-Jersey Transmission Corp.**—265 miles 24-in., planned, from Oakford Storage field in western Pennsylvania to Texas Eastern Transmission Corp.'s Compressor Station No. 26 near Lambertville, N. J. Estimated cost $30,755,000.

• **Texas Gas Transmission Corp.**—48 miles, 26-in., planned, loops from Memphis to Slaughters, Ky.

24 miles, 16-in. line proposed from North Tepetate field, Acadia Parish, Louisiana, to South Roanoke field in Jefferson Davis Parish, Louisiana.

• **Texas-Ohio Gas Co.**—1,435 miles, 30-in., proposed, Hidalgo County, Texas, through Arkansas, Mississippi, Tennessee, and Kentucky on to Spencer, W. Va.

• **Transcontinental Gas Pipe Line Corp.**—421 miles, 30-36-in., looping along Texas-New York line.

19 miles of 12.75-in. pipe starting at West White Lake field in Vermilion Parish, Louisiana, and connecting with applicant's transmission line in same parish. Estimated cost: $1,042,310.

• **Trans-Northwest Gas, Inc.**—246 miles, proposed, International Boundary near Osoyoos, B. C., to Washington and Idaho.

275 miles, branch lines.

**United Gas Fuel Co., and Central Kentucky Natural Gas Co.**—57 miles contracted, to Putnam County, West Virginia. H. C. Price Co.

• **United Fuel Gas Co.**—52 miles, 20-24-in., proposed, Wood County to Lanham, W. Va. Spring 1954.

57 miles, 30-in., proposed, Lanham in Kanawha County, West Virginia, to Gulf Interstate line in Boyd County, Kentucky. Spring '54.

**United Gas Pipe Line Co.**—44 miles, 20-in., under way, Lirette field to Harvey, La. Brown & Root.

**Utah Natural Gas Co.**—63.7 miles of 18-in. line completed by R. H. Fulton Co. from Clear Creek field to Orem, Utah.

40 miles from Orem to Salt Lake City will be built of 16-in. pipe at later date. Contract not let yet.

**Virginia Natural Gas Co.**—153 miles, Buckingham to Richmond and Portsmouth, Va.

**Warren Pipe Line Co.**—25 miles of 3-20-in. being laid in Garvin County, Oklahoma, by George W. Davis Co. Completion date not set.

**Westcoast Transmission Co., Ltd.**—(See foreign natural gas pipe lines).

### Foreign Crude-Oil Pipelines

• **Arabian American Oil Co.**—18 miles, 22-20-in., planned, Qatif to Ras Tanura No. 3. Completion date 1-55.

**Bombay Port Trust.**—50 miles, 8 to 24-in., contracted, Bombay, India, to serve Standard Vacuum Oil Co., and Burmah Shell refineries. Merritt, Chapman & Scott Corp., contractors. (Crude and Products.)

**Creole Petroleum Corp.**—21 miles, 34-in. crude line to run from Lagunillas field to La Salina, Venezuela. Williams Brothers Overseas Co. has contract with construction slated to start in February and to be completed in 6 months. Line when completed will be the world's largest-diameter crude line.

**Direccion General de Yacimientos Petroliferos Fiscales**—409 miles, under way, Plaza Huincul to Bahia Blanca, Argentina.

**Estrada De Ferro Santos A Jundiai Oleoduto Santos—Sao Paulo.**—This Brazilian company has completed or recently started the following lines:

2 miles, 24-in. crude line from Junction to Refinery at Capuava. Completion, May 1954.

21 miles, 12-in., planned from Cubatao to Capuava refinery. Completion scheduled for June 1954.

• **Gaz de France**—200 miles, 12-in. Ruhr to Paris, France.

**Interprovincial Pipe Line Co. and Lakehead Pipe Line Co.**—Contracts have been awarded for 604 miles of looping; 454 miles will be in Canada, the remaining 150 miles will be in the United States.

201 miles of 24-in. between Regina and Gretna, Man., have been awarded to Anderson International Contractors, Ltd., of Edmonton, Alta.

Mannix, Ltd., of Calgary, Alta., will lay 129 miles of 24-in. line between Edmonton and the Alberta-Saskatchewan boundary.

Shown above, at the world's deepest well, is L.W. Potter and one of his radio-controlled Thompson Unitized Vacuum Tanks which hauled and cleaned up all fluids used on the site.

- ☐ Transfer rotary mud
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- ☐ Clean Tanks
- ☐ Transfer acid, acid sludge, caustics
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- ☐ Oil roads
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Fulton-Bannister, Ltd., has contract for 125 miles of 24-in. line to connect the lines being built by Anderson and Mannix.

R. H. Fulton & Co., of Lubbock, Tex., has the contract for 104 miles of 26-in. looping from the Canadian border southeast and for a 43-mile section northwest from Duluth, Minn.

• **Mid-Saskatchewan Pipelines, Ltd.**—Proposed line from Smiley Viking oil field to connect with Interprovincial Pipe Line Co.'s Kerrobert pump station.

• **Petroleos Mexicanos.**—145 miles, 12-in., considered, 18 de Marzo field via Reynosa to Monterrey, Mexico.

100 miles, planned, Ishthmus of Tehuantepec, Jose Colomo to El Plan field, Minatitlan.

72 miles, 12-in., proposed, Poza Rica to Atzacapotzalco, Mexico.

**Petroleos Mexicanos.**—125 miles, 10-in., under way, Jose Colomo to El Plan, Mexico.

• **Saskatoon Pipe Line, Ltd.**—56 miles, 6-in., planned, Milden to Saskatoon, Sask.

**Texas Petroleum Co.** — 60 miles, 4-6-in., under way. Pta. Nino de La Dorada.

• **Trans Mountain Oil Pipe Line Co.**—30 miles, 20-in. from Vancouver to General Petroleum's refinery under construction at Ferndale, Wash.

20-in. line planned from Ferndale to Burlington and a 16-in. line planned to Shell Oil Co.'s refinery under construction at Anacortes, Wash.

• **Yacimientos Petroliferos Fiscales Bolivianos.**—170 miles, 4-in., planned, Bermejo to Tupiza, Bolivia.

### Foreign Products Pipelines

**Anglo-Iranian Oil Co., Ltd.**—18½ miles, 16-in., under way, Little Aden to Aden. Bechtel Corp. Completion date December 1954.

18½ miles, 6-in., under way, Little Aden to Aden. Bechtel Corp. Completion date December 1954.

15 miles, 12-in., under way, Kwinana to Fremantle, M. W. Kellogg Co. Completion date February 1955.

17 miles, 6-in., Kwinana to Fremantle. M. W. Kellogg Co. Completion date February 1955.

• **Empresa Nacional del Petroleo** — 80 miles, 6¾-in., planned, Concon to Santiago, Chile.

• **Governments of Southern Rhodesia and Portuguese East Africa.**—200 miles, considered, Beria, Portuguese Mozambique to Umtalia, Southern Rhodesia.

**North Atlantic Treaty Organization (NATO)**—1,920 miles, 4-10-in., to serve military bases in Western Europe (to connect with U. S. Government's St. Nazaire-Paris-Metz line.) Contracted by Soc. Foster Wheeler Francaise.

• **Petroleos Mexicanos.**—124 miles, 6-in., planned, Lagos to Guadalajara, Mexico.

54 miles, 6-in., planned, Lagos to Aguascalientes, Mexico.

82 miles, 8-in., planned, Salamanca to Lagos, Mexico.

• **United States Government.**—375 miles, 12-in., planned, St. Nazaire to Melun and Metz, France.

### Foreign Natural-Gas Pipelines

**Azienda Generale Italiana Petroli** — 90 miles, 12-in., under way, Cortemaggiore to Bologna, Italy, SNAM crews.

120 miles, 16-in., under way, Cremona Porto Mar to Ghera, Italy, Montubi, contractor.

40 miles, 12-in., under way, Ripalta-Bergamo, Italy.

• **Burma Oil Co., Ltd.**—350-mile, 16-in. line planned from Sui field to Karachi in West Pakistan. Estimated cost: $25,000,000.

**Direccion General del Gas del Estado**—310 miles, 8-in., under way, Plaza Huincul to Neuquen, Argentina, to the vicinity of General Conesa, Argentina.

• **Empresa Nacional del Petroleo** — 80 miles, 10-in., planned, Concon to Santiago, Chile.

• **Northwest Natural Gas Co.**—950 miles, 24-in., planned, Alberta fields to Vancouver, B. C., Seattle, Wash., and Portland, Ore.

**Petroleos Mexicanos.** — 205 miles, 16-in., under way, Monterrey to Torreon, Mexico.

• **Petroleos Mexicanos.**—440 miles, 20-in., planned, Brazil to Tampico to Poza Rica, Mexico.

• **Tennessee Gas Transmission**—75 miles of undetermined size pipe proposed from Buffalo to Toronto. Proposal passed Canadian Senate will go before parliament probably in April 1954.

• **Trans-Canada Pipe Lines, Ltd., (Canadian Delhi Oil Co.)**—2,247 miles, 14 to 30-in., proposed, Alberta to Toronto to Montreal.

747 miles, 8 to 24-in., gathering system in Alberta.

• **Union Gas Co. of Canada, Ltd.**—Proposed line from Lambton County gas-storage fields to Oakville. Line is being proposed now and will eventually join with proposed line from Alberta to Toronto and Montreal.

• **Westcoast Transmission Co., Ltd.**—932 miles, 24-in., planned, Ft. Saint John, B. C., to Spokane, Seattle, and Portland. Ford, Bacon & Davis, Engineers.

138 miles, 20-in., planned, Sumas to Tacoma, Wash.

139 miles, 18-in., planned, Tacoma, Wash., to Portland, Ore.

• **Western Pipe Lines.**—833 miles, 24-in., proposed, from southern Alberta, eastward across the Canadian prairies, serving principal towns and cities along the route.


## "King-Size"* 1953 Pipe Line Wall Charts

1. Crude Oil and Products Pipe Line Map
2. Natural Gas Transmission Pipe Line Map

$2.00 —Both Maps— $2.00

*The largest maps ever published by The Journal—42" x 56"—printed in color on both sides of one sheet. Here are two maps with up-to-date details on all existing and proposed pipe lines in the United States and Canada.

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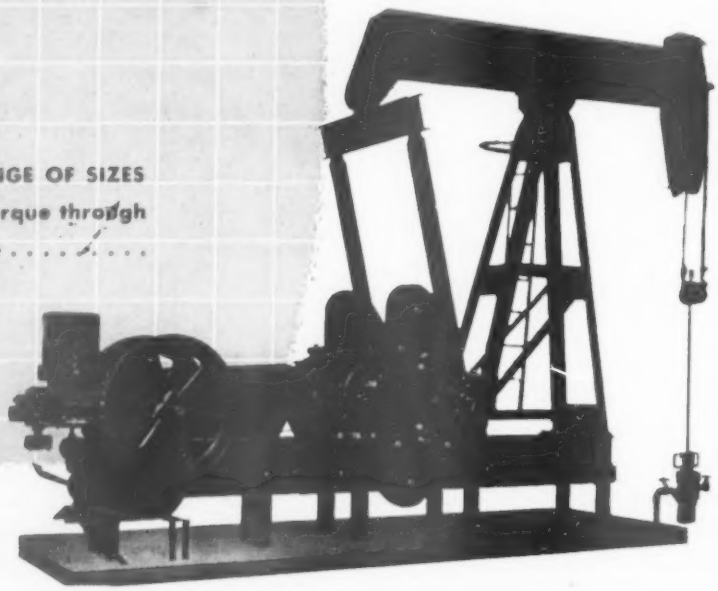

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**LARGE UNITS** — crank balanced — optional economical filler weight type or adjustable type with unique ratchet adjustment feature.

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**BASE** — optional elevated gear box for floor clearing cranks.

**WALKING BEAM** — heavy CB beams — adjustable for alignment — loaded for max. strength.

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# EQUIPMENT MEN . . . in the News

## Wilson to Distribute Carter Pumps in New Area

S. C. Carter Co., Inc., Los Angeles, has announced that Wilson Supply Co., who already distributes Carter long-stroke hydraulic pumping units in South Texas, Louisiana, and Arkansas, has now been appointed exclusive distributors for New Mexico and all of Texas, except the Panhandle.

Sales and service of Carter units will be handled, under Ralph Crenshaw, from Wilson's office at Houston and branches throughout the territory. Jack Baker, formerly with Smith & Baker Sales Co., Odessa, Tex., will be Wilson's field representative for West Texas.

## O'Malia Heads Chrysler Industrial Engine Sales

J. E. O'MALIA

Appointment of J. Emmett O'Malia as supervisor of sales engineering for Chrysler Corp. marine and industrial engine division has been announced by C. C. Williams, general manager of the division.

O'Malia has been with the marine and industrial engine division since 1943, and during this period has been active in expediting, pricing, specifications, sales, and application engineering.

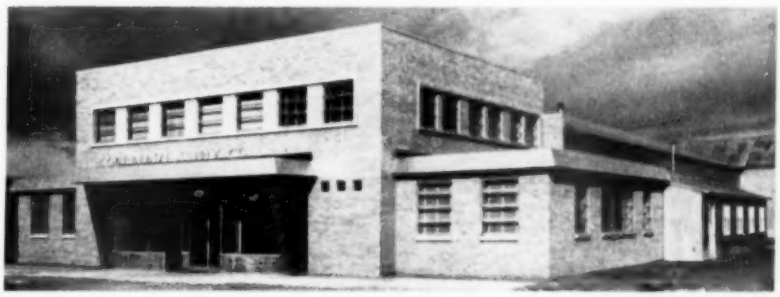
The new supervisor started his career with Chrysler in 1936 and served in all phases of engine assembly, scheduling, and special assignment.

## B.S.&B. Names Two New Representatives

Black, Sivalls & Bryson, Inc., Kansas City, announces the appointment of two new manufacturer's representatives for its line of automatic control equipment and safety heads.

Fluid Controls Co., Inc., with headquarters at Philadelphia, will cover the District of Columbia and the states of Maryland and Virginia, except the extreme western counties. Fred C. Hasselberg, at Richmond, Va., and Benjamin Volker, Baltimore, are sales representatives for the company.

Berry Ervin Engineering Co., Minneapolis, will cover Minnesota, North Dakota, eastern South Dakota, and western Wisconsin. George W. Sayer, owner; Carroll Cross; and Berry Ervin will represent the company.



## Continental Opens Casper District Office

**The Continental Supply Co. has formally opened its new Casper, Wyo., district office, store, and warehouse. Under the direction of District Manager W. D. Craig, Casper serves as headquarters for the company's entire Rocky Mountain operation. The front portion of the new building houses the store on the first floor and district offices on the second. The rear of the building is a large warehouse. Continental has operated in Casper since 1913. Other points in the company's expanding operation in the Rocky Mountain area are: Williston, N. D.; Newcastle and Cody, Wyo.; Cutbank and Glendive, Mont.; Artesia and Sterling, Colo.; and an office in Denver.**

## Kaiser Appoints Webber To New Sales Post

Appointment of J. H. Webber as assistant manager of tubular products sales, general offices, Oakland, Calif., and T. H. Wakeman as Mid-Continent district sales manager, Tulsa, has been announced by C. F. Borden, Kaiser Steel Corp.'s vice president in charge of sales.

J. H. WEBBER

T. H. WAKEMAN

Webber was sent to Oakland from Tulsa where he was Mid-Continent sales manager. A graduate of University of Montana, he joined the steel sales staff in 1946.

Wakeman, a graduate of California Institute of Technology, joined the Kaiser Steel sales staff in 1950. In 1951 he served as assistant to the manager of tubular sales. Prior to his newest appointment, Wakeman was Mid-Continent district sales representative with offices in Houston.

## Duncan Joins Cardwell In Sales Promotion Post

Dan Duncan is now in charge of sales promotion and product research of Cardwell Manufacturing Co., according to a recent announcement by the company. Duncan has been in the oil industry for over 33 years, and served with Shell Oil Co., The National Supply, Bell & Loffland, Emsco, and Ideco before joining Cardwell.

Duncan will make his headquarters in the Cardwell home office at Wichita, Kans.

## Armco Acquires Stock of Southwest Steel Products

Armco Steel Corp. has completed negotiations for the acquisition of all of the common stock of Southwest Steel Products.

This was announced by R. L. Gray, vice president of Armco and president of Sheffield Steel Corp., who represented Armco in the negotiations, and Russell L. Jolley, president of Southwest, who represented the stockholders of Southwest.

Southwest was incorporated in 1946 by Jolley, a group of his business associates, and a group of business people in Houston. The company has three

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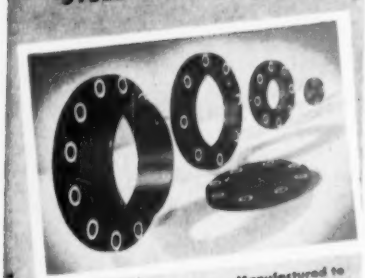

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## Distillation Tower Moved on Eight Trailers

**Eight Spencer-Safford Loadcraft single-axle, tandem-pole trailers, being pulled in tandem by a heavy-duty International Harvester truck, transport a 350,000-lb. load from Odessa, Tex., for Phillips Petroleum Co. Spencer-Safford Loadcraft, Inc., originally Spencer Trailer Co., started fabricating the many-purpose type trailer in 1916 for transporting pipe, derricks, masts, tanks, and large skid-mounted equipment.**

plants in Houston producing fabricated reinforcing bars, bar joists, roof deck, steel forms, and plate products.

Jolley, who along with the others active in the Southwest organization will continue in charge of the business as a wholly owned subsidiary of Armco, stated that the company would liquidate its Southwest Steel Plate Division, and that the company in the future would concentrate on the production of bar joists, roof deck, steel forms, and other accessories for the construction industry.

## Payte to Head Petrofluid Conditioning Firm

D. F. Payte, general manager, Empire Machinery Co., Dallas, has been named general manager of the newly formed Petrofluid Conditioning Co. with headquarters also in Dallas. The new company, headed by Payte, will be devoted exclusively to the distribution of Evis oil and water conditioners to petroleum producers and refiners throughout the Southwest, with the exception of West Texas which will continue to be serviced by Empire Machinery.

Payte has been active in sales and service of oil-field equipment since 1927. Associated with Payte in the new company is Thad Patrick, who will serve as chief engineer.

Evis oil and water conditioners, marketed by the new company, have proved effective in solving many difficult oil-field problems concerning the density of drilling muds, the separation of fluids, and the elimination of mineral scale in water-using equipment.

## Warner Makes Anderson General Sales Manager

Norman K. Anderson has been named general sales manager of Warner Electric Brake & Clutch Co., Beloit, Wis.

Anderson, who had been manager of Warner's industrial division, joined the firm in 1946. Prior to that time he was associated with DeVilbiss Corp. and Fairbanks, Morse & Co., acting as sales engineer for both concerns.

## Foxboro Factory Nears Completion in Dallas

A new branch factory, now being erected will double the Dallas facilities of The Foxboro Co., Foxboro, Mass., manufacturer of industrial instruments for process measurement and control. The expansion reflects the growing demand for instrumentation by the region's industrial users, especially in the petroleum refining, natural gas, chemical, and petrochemical fields.

Scheduled for occupancy on April 30, the new building will provide 13,000 sq. ft. of space for increased instrument manufacturing activities, service and repair, and centralized warehousing of instruments and control valves, in addition to enlarged quarters for the sales office.

In addition to sales offices in other Texas cities, the company maintains emergency repair shops in Houston and Corpus Christi, Tex. Nationally, there are two other Foxboro branch factories in San Francisco and Pittsburgh, with additional repair facilities located in Chicago, Los Angeles, Denver, and New Orleans.

## Ingalls Group Names Harrison to Houston Area

Charles W. Harrison has been appointed sales engineer for the Houston district of The Ingalls Iron Works Co. and its subsidiaries, Ingalls Shipbuilding Corp. and Ingalls Steel Construction Co.

Harrison is a native of Dallas, and a graduate of Georgia Institute of Technology and University of Houston.

Prior to joining the Ingalls organization, Harrison was the Houston representative for Parkersburg Rig & Reel Co.

Harrison will make his headquarters at Houston, where he will represent all of the Ingalls companies including Birmingham Tank Co. division.

## Lane-Wells Names Platt As Personnel Manager

L. J. PLATT

Leonard J. Platt, industrial relations and personnel executive, has been appointed personnel manager of Lane-Wells Co., according to Rodney S. Durkee, president. Platt will be stationed in Los Angeles.

He served with Douglas Aircraft Co., handling important employment, wage and salary, labor relations, and general personnel assignments. He served in a similar capacity with Northrop Aircraft Co. for several years. Later, he was assistant personnel manager of the Civil Aeronautics Administration of the United States Government. He was also with T.W.A. as assistant director in charge of personnel work overseas in 19 countries.

## Dekoron Tubing Becomes Dekoron Products Division

Samuel Moore & Co., Mantua, Ohio, producer of Dekoron coated instrument tubing and Impervapak instrument line harness, has announced that the Dekoron Tubing Division, which handles sales of these items, will henceforth be known as the Dekoron Products Division.

Change in name is more descriptive of activities of the division since products will also include copper tubing.


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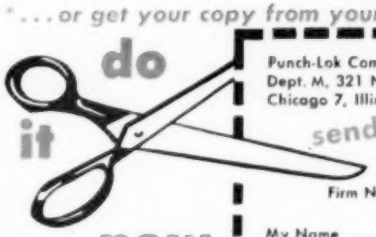


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## LauBach Elected President Of Cooling Tower Institute

Neal B. LauBach, Hudson Engineering Corp., Houston, has been elected president of the Cooling Tower Institute, the national association of manufacturers of industrial water cooling equipment.

Other new officers are: Paul R. Hoffman, Lilie-Hoffman Cooling Towers, Inc., St. Louis, vice president; Clayton E. Pickup, The Flour Corp., Ltd., Los Angeles, secretary; and Robert R. Pabodie, United Cooling Tower Co., Kansas City, Mo., treasurer. President for the 1953 term was Leon T. Mart, of The Marley Co., Kansas City, Mo.

The institute is now developing a field testing technique for industrial cooling towers with specially designed test instruments, assembled in the Houston area.

New officers of Cooling Tower Institute are: Paul R. Hoffman, Neal B. LauBach, Clayton E. Pickup, and Robert R. Pabodie.

## Page Oil Tools Sends Coziar to Mid-Continent

R. L. COZIAR

John Page, president of Page Oil Tools, Long Beach, Calif., has announced that Russell L. Coziar has been transferred from Long Beach to Midland, Tex., where he will make his headquarters.

Coziar is the Page factory representative in the Mid-Continent and will supervise service and sales activities, concentrating particularly in West Texas and Permian basin areas. His work will be chiefly with supply houses and customers handling various phases of the company's line of production equipment.

Coziar came to Page 4 years ago from Sargent Engineering Co.

## Lincoln Electric Adds Three to Field Service

The Lincoln Electric Co., Cleveland, has added three men to its field staff of application engineers for servicing industrial users of arc welding.

Jack Jaso, an engineering graduate of Cornell University, joined Lincoln following a term of service in the Navy. He has been assigned to the Chicago district as an application engineer.

Walter Rockway is serving industry in the Cincinnati district. He is a me-

## Houston Nomads Induct 11 New Members

**The Houston chapter of Nomads inducted 11 novices at its March meeting held at College Inn. Above are the inductees, along with three prominent guests of the evening. Front row are: J. W. Wallace, National Tank Co.; A. H. Beal, Oil Well Survey Instrument Co.; A. D. Cathey, Cameron Iron Works; Jack G. Walker, Magnet Cove Barium Corp.; E. H. Lancaster, Magnet Cove Barium; and U. V. Seales, Hunt Tool Co. In the back row are: R. J. Young, Shell Oil Co., Houston; M. T. Childress, Gray Tool Co.; Leslie W. Jones, Baroid Sales Division; Bruce Barkis, B & W Inc.; Laurence B. Murray, Continental Supply Co.; Spencer W. Robinson, Drilling Magazine; L. W. Storms, Pantepec Oil Co., Caracas, Venezuela; and J. N. White, Glenn McCarthy, Inc., Bolivia.**

*for Oil Country Application...*

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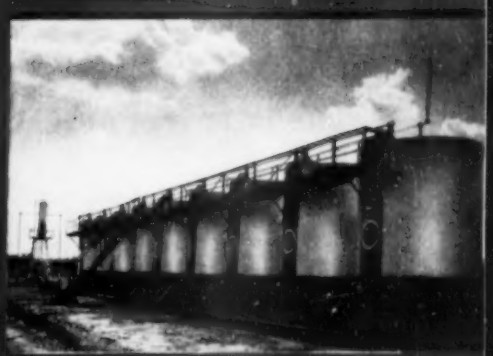
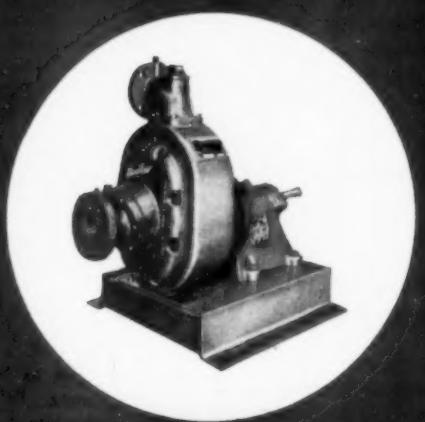
*there's a reason...*



# DURABILITY



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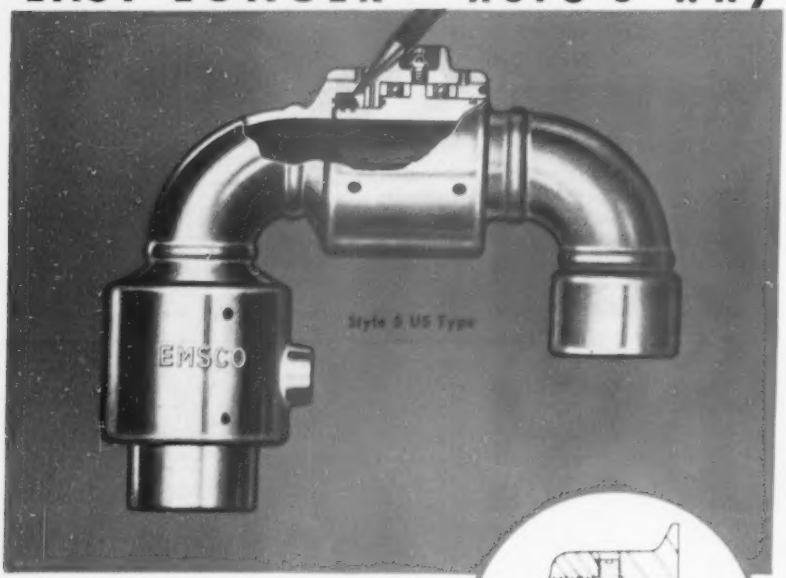
# EMSCO SWIVEL FITTINGS LAST LONGER — here's why



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3. LONG LASTING

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Emsco "free turning" Ball Bearing Swivel Fittings are manufactured for almost every type of service, from high vacuum to pressures of 15,000 psi., and from sub-zero temperatures to 750°F. Complete information, prices and delivery upon request.

Deformable packing extruded into annular grooves assures a positive seal. This Emsco patented method does not affect ease of turning. Any packing material such as asbestos, Blue African Asbestos or Teflon may be used in the US Type fitting.

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BOX 2098, TERMINAL ANNEX

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chanical engineering graduate of University of Washington. His experience includes engineering the application of industrial electrical equipment for General Electric.

Chester Shira is an application engineer for the Jacksonville, Fla., district. He has a degree in welding engineering from Ohio State University, which is the only university in the United States offering a 5-year course and a degree in this subject.

## Scoggan Is Assistant Sales Manager for C. Lee Cook

J. E. SCOGGAN

The appointment of John E. Scoggan as assistant sales manager of C. Lee Cook Manufacturing Co., Louisville, Ky., has been announced by Fred D. Durham, president of the company. Cook manufactures a diversified line of industrial piston rings and metallic rod packings.

Scoggan was formerly in the firm's engineering and production control departments. In the latter, he was production manager.

Prior to joining C. Lee Cook, Scoggan was with Curtiss-Wright Co. as a blade design engineer. He is a graduate of Purdue University and holds a B.S. degree in mechanical engineering.

## Miller Goes to Peru For Oil Base, Inc.

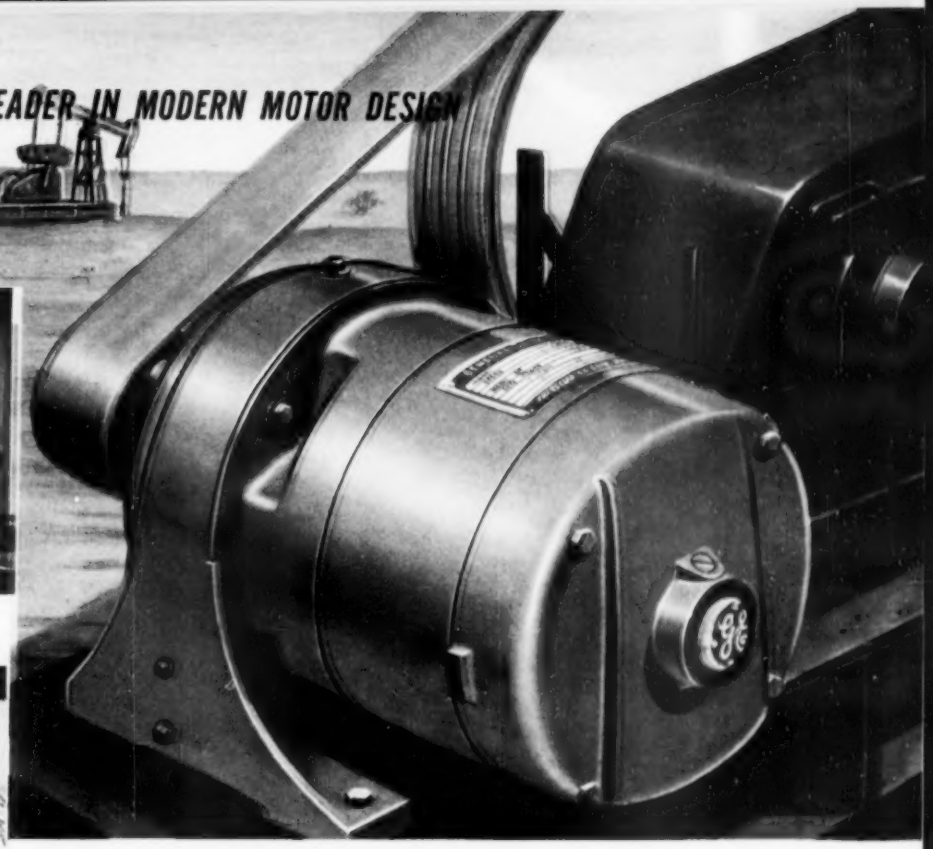
George Miller, president of Oil Base, Inc., Compton, Calif., recently flew to Peru for a 2-month business trip through South America. He plans to confer with Stan Parfet and Guido De Rossi, Servicios Petroleros S. A. of Lima, representatives for Black Magic, White Magic, No Glo, Super Mix, and other drilling fluids and additives manufactured by Oil Base.

Together they plan an extensive visit of producing fields, and will make a survey of sales possibilities for Oil Base drilling fluids in these areas. Miller will return to Compton the latter part of April.

## Tener Joins Hercules

Sam A. Tener has been appointed to the staff of Hercules Tool Co., Tulsa, by S. P. Tschappat, president. He will serve as sales representative in Oklahoma, Panhandle of Texas, and the Wichita Falls, Tex., area. Tener was formerly with Robinson Packer Co.

**TRI 55 CLAD** THE LEADER IN MODERN MOTOR DESIGN



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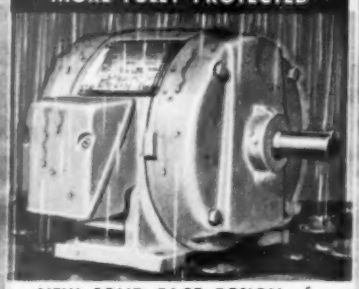

**NEW SOLID FACE DESIGN** of end shields, *louvered* exhaust vents help keep moisture out.

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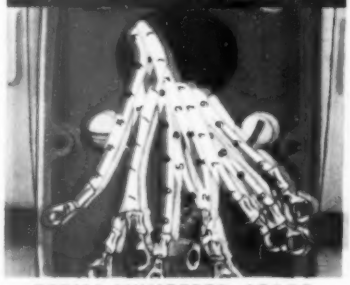
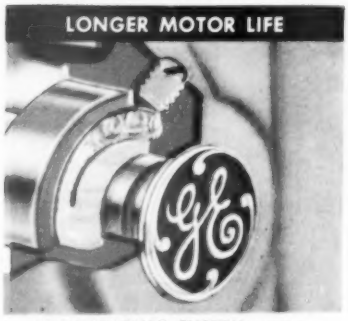
**NON-WICKING LEADS**



**PERMA-NUMBERED LEADS** won't wick water into the motor—assure quick identification.

**LONGER MOTOR LIFE**



**NEW BEARING SYSTEM** means the G-E motor runs longer without relubrication than any other.

## Now, important advances in motor protection . . .

# New TRI 55 CLAD motor gives you longer motor life . . . outdoors or in!

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Here is a dripproof motor that can be properly applied to outdoor applications like oil well pumping. It's the new G-E Tri-Clad '55' motor with more physical protection . . . more electrical life.

Here are some of the protection features that add to the life of this new motor. End shields and frame are rust-resistant cast iron. Air vents are protected at the base of the end shield—not exposed on the face. Side exhaust vents are *louvered*. To help prevent moisture damage, the insulation system of the new Tri-Clad '55' motor incorporates newest materials like a silicone stator coating and polyester-film for slot and phase insulation.

The new Tri-Clad '55' motor is simple for you to install. Diagonally split conduit box offers ample knuckle room and leads are perma-numbered for instant reading. Stainless steel nameplate carries wiring diagram. Lock-in screens for rodent protection are available.

General Electric Tri-Clad '55' motors are now available in many ratings. Complete line of 1 to 30 hp a-c motors will be available soon. For full details contact your G-E Apparatus Sales Office or G-E Motor Supplier today. Write for Tri-Clad '55' bulletins GEA-6013—Dripproof motors, GEA-6012—Enclosed motors, GEA-6027—Gear-motors. General Electric Company, Section 648-11, Schenectady 5, New York.

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# NATURAL GAS

## Pipeline Questioned

### Common carrier tag asked for Montana-Dakota line

BISMARCK, N. D.—A lawsuit seeking to declare Montana-Dakota Utilities Co.'s natural-gas pipeline from Wyoming-Montana to North Dakota a common carrier has been filed in U. S. District Court here. Plaintiffs are Industrial Gas Co. and Mondakota Gas Co. John White of Billings, Mont., is president of both firms.

Following adoption by Congress August 12, 1953, of an amendment to the Mineral Leasing Act, Montana-Dakota filed with the Federal Power Commission a proposal to cancel its tariff and notified the plaintiffs that it would continue to transport gas under existing service agreements, but would enter into no new agreements.

Montana-Dakota contends that since it is subject to regulation under the Natural Gas Act and since it also is subject to state regulatory agencies, it qualifies under the August 12 amendment, which relieves the common carrier obligation of the Mineral Leasing Act to pipelines crossing federal land.

The plaintiffs contend the amendment does not apply to existing pipelines, but to lines laid before passage of the act. They ask that Montana-Dakota be compelled to accept two new applications for service agreements. The plaintiffs say Montana-Dakota is the only available transportation between production in Wyoming and Montana and customers in North and South Dakota.

Montana-Dakota in support of its argument cites a conference report on the bill which quotes a House of Representatives spokesman as saying, "The object of the legislation is to relieve certain pipelines used by regulated public utilities from the common obligation for reasons conceded to be reasonable and just."

While the existing service agreement covers three customers of White's firms, Montana-Dakota says only one, Eastern Clay Products Co. at Belle Fourche, S. D., is being served under a service agreement. The other two, South Dakota's State Cement Plant at Rapid City and American Colloid Co. at Belle Fourche, now are being served by Montana-Dakota under long-term contracts, the company said.

## FPC Studying Exemptions Found in New Amendment

WASHINGTON.—Chairman Jerome K. Kuykendall has announced the Federal Power Commission is considering a proposed rule to make effective exemptions granted by the Hinshaw Amendment, which recently was passed by Congress and approved by the President.

The amendment provides that any company purchasing natural gas at or within a state boundary is exempt from provisions of the Natural Gas Act if all the gas is consumed within the state and if rates, service, and facilities are regulated by a state commission.

Kuykendall said the FPC is requiring a "minimum of information" from companies seeking the exemption. The information will be used by state commissions to make the necessary examinations and file certificates with the FPC, he added.

## FPC Report Indicates Speedup in Rate Cases

WASHINGTON.—The Federal Power Commission last week announced it disposed of more natural-gas rate cases during the 9-month period ended April 1 than it did in the two preceding fiscal years combined.

Twenty-six cases involving $115,648,600 in proposed wholesale increases were handled during the period, the agency said. Still pending are 36 rate cases involving about $103,608,000 in increases.

Of the total $115,648,600 involved, cases representing $21,490,500, or 27.2 per cent, were disallowed. Of the remainder, $81,990,100 was disallowed and $2,168,000 was withdrawn as a result of settlements in related cases.

During the entire preceding fiscal year, the commission disposed of 10 cases involving $49,277,000.

## Rate Increase Suspended

WASHINGTON.—The Federal Power Commission has suspended a proposed $694,000, or 31 per cent, annual wholesale natural gas rate increase by Kansas-Nebraska Natural Gas Co., Inc., of Phillipsburg, Kans., pending a hearing. Kansas-Nebraska filed the proposed increase March 8. It would have gone into effect April 8 if the FPC has not ordered the suspension.

## FPC About-face

### Members reported drafting new gas rate-fixing policy

WASHINGTON.—The Federal Power Commission reportedly is writing a decision in the Panhandle Eastern Pipe Line Co. rate case that will permit the company to value its own gas at the field price.

Such a decision would reverse the commission's policy. In the past, the policy has been that the value of gas reserves held by a transmission company shall not exceed the actual original cost.

In an effort to avert the reversal of policy, Rep. Charles G. Oakman of Michigan asked the House commerce committee last week to give immediate consideration to his bill to write the original-cost formula into the Natural Gas Act.

In explaining his bill to the committee, Oakman was asked whether he believed a pipeline company should be penalized for its foresight in acquiring gas reserves in anticipation of future needs and whether rates should be based on original cost or cost of replacement.

Oakman contended by paying their rates, consumers pay for gas reserves of the pipeline companies and should be protected "from paying nearly 150 times the cost of the gas" their own money has produced.

**Would set pattern . . .** Panhandle controls about 7,000,000 M.c.f. of gas under purchase contracts, Oakman said. A writeup of just one cent a 1,000 cu. ft. would increase the cost of that gas by $70,000,000, a 10-cent writeup by $700,000,000, and "the Panhandle company alone will receive a total of at least $1 billion of additional profit merely as a result of a change in regulatory philosophy."

He said giving Panhandle the field price for gas would set a pattern for other companies to seek rate increases.

The tentative vote to give Panhandle the "fair field price" on its own production reportedly was 4 to 1, with Commissioner Claude L. Draper dissenting.

There are strong indications that if the final opinion grants field prices to Panhandle the issue will be taken to the courts. The State of Michigan, the city of Detroit, the county of Wayne and the United Automobile Workers Union have filed a petition with the FPC to reopen the case to consider new evidence, and if that effort fails are expected to challenge the validity of the commission's ruling.

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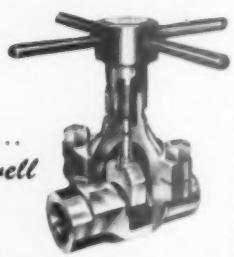

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INDIANA

# Among the Drilling Contractors

## Contractor Reduces Costs With Trailer-Mounted Rig

Use of a trailer-mounted rig is enabling Don Johnson Drilling Co., of Oklahoma City, to reduce substantially its costs of exploratory drilling.

Savings are effected not only by the rig's mobility which makes possible quicker moves from location to another, but also by "slim-hole" drilling practices normally followed when using the rig.

Since most of the holes drilled with the rig primarily are for exploratory purposes, slim-hole drilling is found adequate. If production is found in a slim-hole exploratory test, it is easy to move off the trailer rig and bring in a skid-mounted rig to ream the hole for larger casing.

The rig, on a recent wildcat test north of Chandler, in Lincoln County, Oklahoma, put down the hole to total depth of 4,257 ft. in 25 days, actual drilling time. It drilled 11-in. surface hole to 135 ft., where 8⅝-in. casing was cemented, and carried 4¾-in. hole to bottom.

Mud pressure was 300 psi. to 1,410 ft., where it was increased to 800 psi. in drilling to 3,451 ft., and then dropped to 750 psi. to completion of the hole. Mud weight averaged 9.8 lb. per gallon. Weight on bit ranged from 4,000 to 7,000 lb. One 11-in. bit and 34 4¾-in. bits were used, averaging 125 ft. per bit. From 3 to 4 hours were required for a round trip from 4,200 ft.

Upon completion of the hole, the rig was moved to a new location near Hill City, Kans., a distance of 460 miles, in 20 hours.

The rig, assembled by National Supply Co., has an Ideal T-12 hoist with a Lee C. Moore 94-ft. telescoping mast, and a C-150 mud pump, and is powered with an 150-hp. engine. All is mounted on a specially built dual-tandem trailer. Three or four men compose the drilling crew.

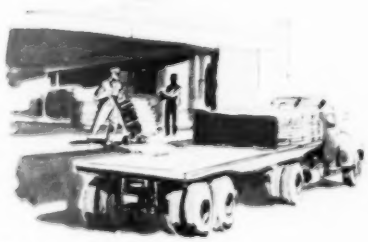
**Chance Drilling Co.**, Houston, is under contract to Kirby Oil & Gas Co. for an 8,500-ft. wildcat test located 6½ miles northwest of Vidor, in Orange County, southeastern Texas. Location is at 1 Paraffin, in Punkley Lout Survey.

**Tri-State Drilling Co.** will handle contract for Commonwealth Oil Co.'s deep Sunniland lime wildcat in Hendry County, southern Florida. The 3 Red Cattle Co., C NE SE 25-45s-28e, is a 12,000-ft. test. It lies 3 miles southwest of Felda and 26 miles southeast of Fort Myers. Nearest production is in Sunniland field, 20 miles to the southeast.

**Fortenberry Drilling Co.** has been let contract to drill a 6,300-ft. Wilcox test west of Sunnyside field in Jefferson County, Mississippi. The wildcat will be John S. Callon and D. A. Biglane C-1 Armstrong, 35-8n-1w.

**Mustang Drilling Co.** is contractor for a new wildcat 4 miles northeast of Boggy Creek field in Cherokee County, East Texas. The test is Stroube &

**Trailer-mounted rig used by Don Johnson Drilling Co., Oklahoma City, in "slim-hole" exploratory-drilling operations. A specially built, dual-tandem trailer is provided. Crew is preparing to raise the rig's 94-ft. mast on a new location.**



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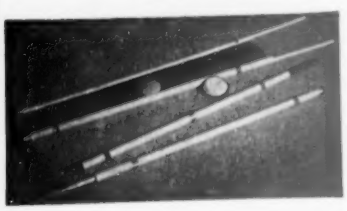

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Stroube and Mustang Drilling Co. 1 Bearden in the George Fossett Survey A-270. **F. R. Jackson Drilling Co.,** Longview, Tex., is contractor for N. E. Loomis 1 Haynes in the William Edmondson Survey A-112 in Marion County, East Texas.

**Southeastern Drilling Co.** will handle contract for I. P. LaRue et al. 1 Batson, C NW SE NW 29-1n-13w, 2 miles north of Pistol Ridge field in Forrest County, Mississippi. It is reported a rig was brought in from Texas for the wildcat.

**Survey Drilling Co.** has contract for a 5,900-ft. wildcat for Gulf Refining Co. at 1 International Paper Co. et al. in the SW SE 12-5n-2e, 1 mile south of Rockville in Clarke County, Alabama. The test is 8 miles north of South Carlton field, nearest production.

**New Drilling Co.** is contractor for Ginther-Warren & Ginther 1 Unit "D" UPRR, SW SW SW 11-3s-60w, Adams County, Colorado. **R. V. Dillard Drilling Co.** is contractor for a new wildcat in Logan County at Lee Swedlund 1 John Binaco, SE SW SW 31-9n-52w.

**Como Drilling Co.,** Tinsley, Miss., is contractor for a 4,500-ft. wildcat, sufficient to penetrate the Wilcox, in Grant Parish, Central Louisiana. The F. A. Callery, Inc., 2 Nebo Oil Co. is in 18-8n-2w, 1¼ miles southwest of Black Creek. There are several shallow tests in this general area which will probably furnish information to top of the Wilcox.

**Reed Drilling Co.,** Tulsa, has contract for Robert M. Boyle 2 Chaney, NW NW NW 32-15n-9e, in the revived development at Tibbens pool in Creek County, northeastern Oklahoma. Prolific pay zone is being tested on the east side of the area at Boyle 1 Chaney, also drilled by Reed.

**J. C. Means, Houston,** is contractor for a 9,800-ft. test on the south side of Krotz Springs field in St. Landry Parish, South Louisiana. The Harry Hurt 1 The Pardee Co. will be in the C N½ NE SW 6-7s-7e, and will possibly go to the Cockfield sands.

**Columbia Drilling Co.** holds contract for a new 8,500-ft. wildcat in northern Victoria County, Texas. Kirby Oil & Gas Co.'s test will be the 1 Foster, on a 239.543-acre lease in T&NO Survey 10, Abstract 472, 19 miles northeast of Victoria. Drill site is about 2 miles east of production in Helen Gohlke field.


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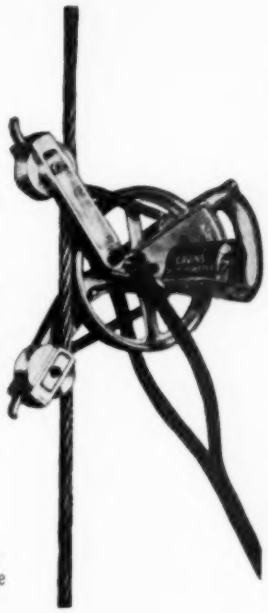

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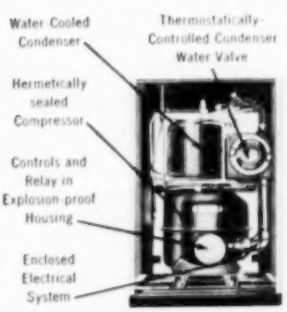


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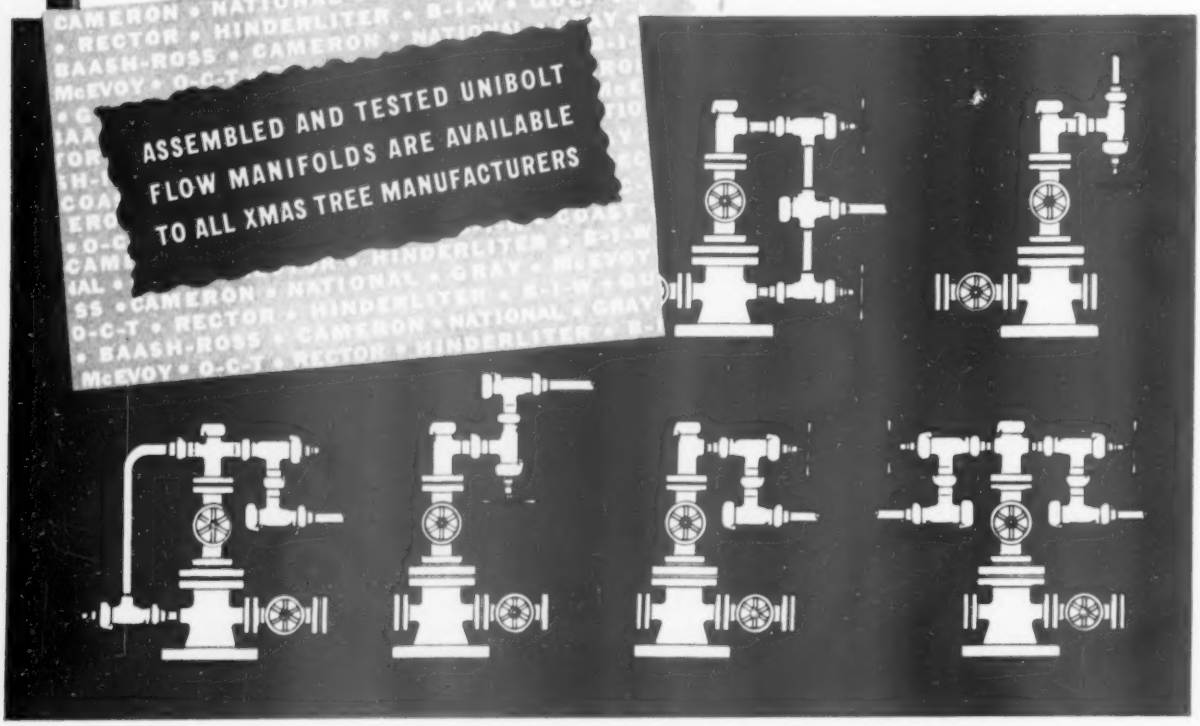

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# REFINING

## Octanes Rising

### More super gasolines, new lube oil announced

NEW YORK.—Gasoline octanes edged further upward on the East Coast last week with the introduction of two more new improved gasolines. Although neither Sun Oil Co. nor Tide Water Associated Oil Co. revealed the actual octane ratings of their new fuels, they both stated that their antiknock qualities were improved.

Sun spiked rumors that it might abandon its single grade policy by announcing the 1954 version of new Blue Sunoco, which it said has higher octane components throughout its distillation curve. It contains no preignition additives. Instead, Sun will shortly announce a new motor fuel which will be designed to reduce engine deposits and preignition problems.

Although the octane rating of the new Sun gasoline has not yet been tested in the industry's routine testing of service station samples, it is believed to be well over 90 research, at least in the Eastern metropolitan areas. Sun maintains catalytic cracking capacity equivalent to about 61 per cent on crude capacity in its two refineries at Toledo and Marcus Hook. This is roughly double the national average and represents the highest ratio of catalytic cracking capacity of any major oil company in the country.

Sun is preparing to maintain its position in processing capacity and octane of its single gasoline grade. New 27,000-bbl.-per-day Houdriflow catalytic cracking units were recently announced for both refineries, replacing some older Houdry units and adding to total capacity. Also announced was a second Houdriforming unit for Marcus Hook. The new 18,000-bbl. unit will be similar to the existing unit recently placed in operation for aromatic chemical synthesis at Marcus Hook, but it will be designed specifically for manufacture of high octane components for aviation and motor fuels.

Tide Water upped the octane, added antistalling ingredients and improved the clean burning characteristics of its new 1954 gasoline, which it calls "Sky High Power" Tydol. The company has begun expansion and modernization work at the Avon, Calif., refinery, and in line with a new policy of investing more heavily in plant facilities, is expected to reveal some new construction plans for the Bayonne, N. J., refinery, probably next month.

**Other developments . . .** In other developments, two other companies announced new products—one a new premium gasoline and the other a new premium gasoline and new lube oil.

Standard Oil Co. of California announced it is distributing a new "detergent-action gasoline designed primarily to eliminate formation of carburetor deposits and to remove existing deposits." The company said field tests also indicate the new fuel eliminates engine stalling, rough idling due to poor carburetion, and improves performance and increases gasoline mileage.

A new premium gasoline developed with additives has been introduced by the Magnolia Petroleum Co. The gasoline is designed to reduce carbon deposits in new high-compression engines. The company also has developed a new lubricating oil that it claims will increase gasoline mileage.

**Alkylate pinch-hitting . . .** The excess of aviation gasoline capacity over immediate requirements has been reflected in the octane numbers and the cleaner burning characteristics of a number of gasoline brands this spring. The increased blending of motor alkylate is expected, in view of the problems involved in engine deposition and preignition. This newly available alkylate is pinch-hitting in a number of cases by providing the hydrocarbon octanes required to keep up with the race, until new catalytic reforming capacity is completed.

Recent surveys indicate that premium grade research octane numbers are up substantially from the first of the year, in both the New York and Houston areas. Arithmetic averages of a number of samples recently taken in both cities show New York octane up from 93.7 to about 94.2 research octane since January 1. In Houston the rise is from 94.1 to 94.8 research octane for premium grades.

## Contracts for Sun's Two Units at Marcus Hook Let

PHILADELPHIA. — Contracts for two additions to Sun Oil Co.'s refinery at Marcus Hook, Pa., have been awarded to Catalytic Construction Co.

One contract covers construction of a Houdriflow catalytic cracking unit with an estimated capacity of 27,000


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bbl. per day. The second contract is for construction of a Houdriformer catalytic unit to produce components for high-grade motor fuel and aviation gasoline. The latter unit will have a daily capacity of 18,000 bbl.

## Esso Expanding

### Baltimore refinery to get three new processing units

BALTIMORE. — Preliminary construction and engineering has begun on a $15,000,000 expansion and modernization program at Esso Standard Oil Co.'s refinery here that will include building fluid coking, Hydrofining and Hydroforming units.

The expansion is designed to increase the refinery's present daily capacity of 58,000 bbl. of crude oil.

The three units proposed in the plant will operate on processes developed by Standard Oil Development Co., Esso's technical research and engineering affiliate.

The fluid coking unit will have a daily capacity of 10,000 bbl. This process converts residual products into additional quantities of gasoline and heating oil. The unit also can utilize crude oils previously felt unsuitable for the economical manufacture of these products.

A 17,000-bbl.-per-day Hydrofining unit proposed for the refinery will replace some of the existing treating equipment. The unit combines several present steps in processing heating oil and gasoline and can produce these products by upgrading low quality crude oils.

The Hydroforming unit, which will have a daily capacity of 3,000 bbl., will replace existing thermal cracking operations. The unit converts low octane petroleum fractions into high octane components.

Foster Wheeler Corp. has been awarded the contract to build and design the Hydrofining and Hydroforming units and Bechtel Corp. will build the fluid coker.

## Cat Reformer Work Near

MUSKEGON. — Construction is scheduled to start here in the near future on a 3,500-bbl.-per-day catalytic reforming unit at Naph-Sol Refining Co.'s plant here.

The addition of the new unit along with other improvements to the general refining operations is expected to boost the refinery's gasoline and naphtha output at least one-third. The refinery's present capacity is 5,000 bbl. daily.

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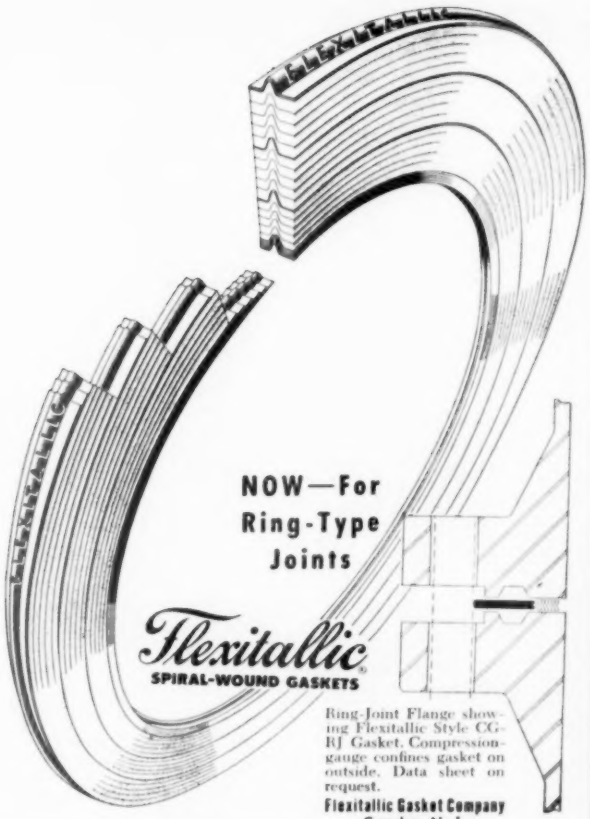


Ring-Joint Flange showing Flexitallic Style CG-RJ Gasket. Compression-gauge confines gasket on outside. Data sheet on request.

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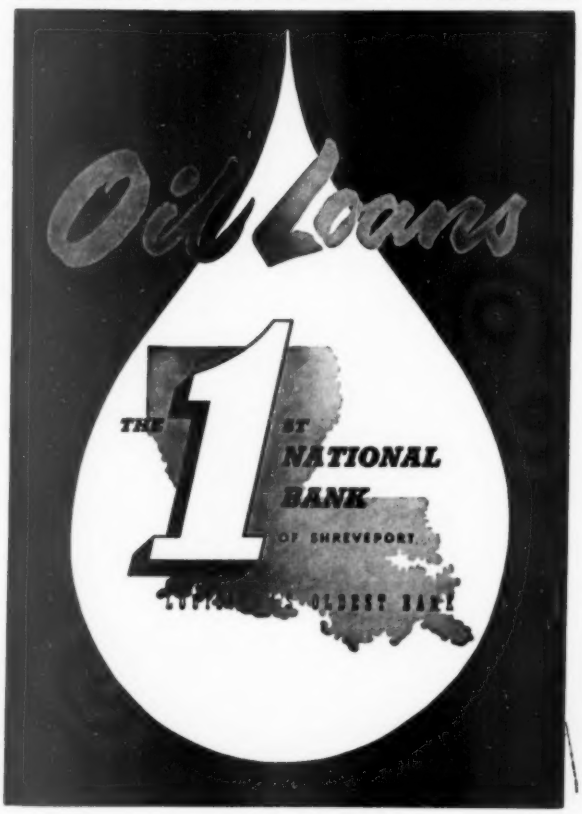

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# PIPELINE

## New Building Aid

### Photogrammetry advantage outlined before engineers

MIDLAND, Tex.—Photogrammetry has a lot of advantages in pipeline construction work, John H. Mitchell, of Great Neck, N. Y., told a meeting here last week of the new Committee on Pipelines of the American Society of Civil Engineers

Economies of the photogrammetric method are primarily realized in the organization, planning, and administration of a project, he said. Mitchell, who is with Lockwood, Kessler & Bartlett, Inc., said economies are conspicuous for several reasons:

. . . **Detailed route projection** is made in the office, unaffected by weather conditions and traveling distances. Stereoptical facilities permit selection of a route requiring a minimum of field revision.

. . . **Stereo-compilation** of strip maps prior to field stakeout enables the right-of-way department to start immediately to procure lands with no wasted effort.

. . . **Accurate projection** of the selected route on the strip map provides a sound basis for immediate acquisition of clearing permits from governmental agencies.

. . . **Cross-sectioning** information for highways, railroads, and rivers may be obtained, permit drawings for them completed, and application made far in advance of centerline survey.

. . . **The ground survey** can be accomplished more effiicently because all right-of-way permits can be obtained in advance; trial survey lines are eliminated since angles and distances of the proposed line on the strip may be protracted and scaled, facilitating close adherence by the survey party to the line selected; and field survey can be scheduled for favorable weather without delaying office design or land acquisition.

. . . **Accurate topographic map** first produced can be used concurrently by designers, right-of-way men, contractors, and survey crews.

. . . **Final maps** supplied the pipeline company contain a wealth of information not included usually on right-of-way maps.

Eldon V. Hunt, construction superintendent for Ebasco Services, Inc., New York, was elected chairman of the committee. He succeeds Charles M. Davis, Fort Worth consultant, who resigned after organizing the committee. Davis becomes an ex-officio member.

The next conference of the pipeline group was set for the A.S.C.E. annual meeting in New York this October.

## Plains Sale OK'd

### Coal firm scheduled to buy Wyoming crude line

CHEYENNE, Wyo. — Sale of the Plains Pipeline system from Newcastle to Lance Creek, Wyo., has been approved by the Wyoming Public Service Commission.

The crude line, with its gathering systems and facilities in Weston County, will be sold to Franklin County (Illinois) Coal Co., a Delaware corporation. It will be sold by John B. Murchison and his brother, Clint Murchison, Jr., both of Dallas, and by an independent group of shareholders represented by Keith Thompson, Cheyenne attorney.

Consideration for the line is quoted at $2,025,000.

Murchison interests bought controlling stock in the line in 1953 *(The Oil and Gas Journal, January 11, page 146)*. The Murchisons hold substantial ownership in Franklin County Coal.

**Expansion completion set . . .** Completion of the major portion of an expansion of the Plains system is slated for completion this week. New facilities which will be placed in service include a 25-mile, 8-in. extension of the system into the new and active South Clareton producing area and the new Red Bird pump station about 50 miles south of Newcastle.

A large portion of the more than 100 miles of new 4-in. gathering lines also will be completed, with the remainder to be placed in service within the next 3 weeks.

The present system consists of an 81-mile, 8-in. line from Newcastle to Lance Creek and 93 miles of field gathering lines serving Mush Creek, Lance Creek, Fiddler Creek, Hay Creek, Black Thunder, and Clareton fields and the Cheyenne River area. The system connects at Lance Creek with two parallel lines running to Guernsey, Wyo., about 70 miles to the south. These are Ohio Oil Co.'s line connecting at Guernsey with Service Pipe Line Co., and


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Rocky Mountain Pipe Line Co.'s line connecting with Platte Pipe Line Co.

Capacity of the system, by virtue of the construction, will be hiked from 17,000 bbl. daily to 30,000 bbl. daily.

## Hearings Reopened on Plans For Colorado Gas System

DENVER.—Hearings reopened here last week before the Colorado Public Utilities Commission on Colorado-Western Pipe Line Co.'s application to lay a $21,000,000, 328-mile natural-gas line from southwestern Colorado to Denver.

Colorado - Western spokesmen were cross-examined by attorneys for Colorado Interstate Gas Co., which currently supplies most of Colorado and which opposes the Colorado-Western application.

Arguments for the application were presented at hearings in Denver March 9 and 10.

The new trunk line would extend from a point in La Plata County in southwestern Colorado, over the Continental Divide, and along the eastern slope of the Rockies to serve Pueblo, Colorado Springs, and intermediate points along the route.

The trunk-line plan was the second laid before the utilities commission by Colorado-Western. The first, which involves construction of a 454-mile, $33,000,000 transmission and distribution system, is set for hearing September 7.

## Gulf Interstate Resumes Work on Big-Inch Gas Line

HOUSTON. — Gulf Interstate Gas Co. has resumed work on its Louisiana-West Virginia big-inch gas line and is scheduled to begin laying pipe again this week.

The 630-mile line is scheduled for completion by November 1. Construction of gathering and lateral lines in South Louisiana is scheduled to be completed early in May. Work on five compressor stations along the line route is about half finished.

## Construction on Shell's Products Pipeline Nears

NEW ORLEANS.—Shell Pipe Line Corp. will begin construction later this month on a 65-mile products pipeline from Shell's Norco, La., refinery west of here to a point near Baton Rouge.

The 12-in. line is scheduled for completion in midsummer. The line will cross about 12 miles of swampland and 2 miles of the Bonnet Caree Spillway.

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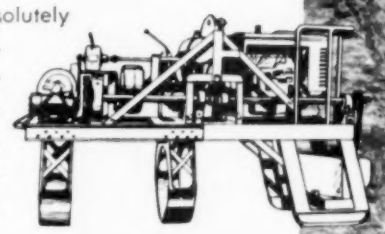

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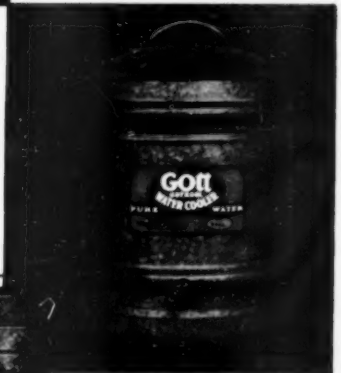


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# EXPLORATION

## What Are Good Geologists Made of?

**by Frank J. Gardner**

DID you know that 37 per cent of the geologists in Texas are left-handed and right-eyed? And that this startling observation implies that they are restless and maladjusted?

Catch your breath—it's true, according to a survey by an organization known as the Human Engineering Laboratory. For the past few years now, this lab has been conducting a series of exhaustive interviews and tests on geological and geophysical personnel of several major oil companies in the Dallas-Fort Worth area. The conclusions they have reached are at once revealing and meaningful, and lend credence to the old observation that geologists must be born, not made.

These soul searchers probe the individual personality for human aptitudes. It seems there are now 13 recognizable and measurable inherent aptitudes, as opposed to acquired or learned abilities. They are independent of the "I. Q." qualities about which we've heard and read so much, but definitely are a contributing force in the mental makeup, and determining factors in the success of an individual in his job.

Only three or four of these aptitudes are enough for a person to achieve success, provided good use is made of the aptitudes in question. It is also possible for one to possess **too many** aptitudes for happiness and success—10 or 12 are the limit here; strangely, of one group of 8,000 people tested, only .01 per cent was found to possess all 13, and a similar .01 per cent lacked all 13. The great "average man" majority possesses six or seven aptitudes.

And how did the geologist-geophysicist fare under the mental microscopes of these human engineers? What were the aptitudes most common among the geological group?

Doubtless, you'll be surprised—there are 11, here listed in order of greatest statistical prevalence in the earth-science category:

**Finger dexterity . . .** Agility with the fingers rates top billing for geological success. How consistently he can plunge his fingers into a series of holes drilled into a wooden block, following preconceived patterns of order, is a key to this quality in the person under observation. The similarity of the test to the geologist's everyday activities with holes and blocks is amusing, but apparently not significant.

**"Tweezer" dexterity . . .** Adeptness at working with small tools is the second most common quality among the oil finders. The scissors, the brush, the ruler, and the pen form the basis of this test.

**Eleven most prevalent aptitudes found among geologists and geophysicists as determined by tests in Dallas-Fort Worth area.**

**Memory for design . . .** The ability to retain a mental picture of outline, form, proportion, and geometric pattern rated high among all geologists tested. This helps, we assume, in memorizing the other fellow's maps.

**Structural visualization . . .** Understandably high on the list of qualities displayed by these oil men was the faculty for visualizing three-dimensional forms—an instinctive ability to construct in the mind's eye from a flat map a clear picture of a solid object. An amusing incident in this field concerned one geologist who had trouble in visualizing faults, and had actively sought employment in an area where he would encounter a minimum number of them.

**Inductive reasoning . . .** Here lies the inborn quality of a trouble shooter. Possession of this trait contributes to diagnostic reasoning and the correlation of unrelated facts.

**Observation . . .** The "inspector's aptitude," leading to a profound sense of detection. Geologists find this ability an essential tool in their profession.

**Memory for numbers . . .** A natural speed and accuracy in remembering and manipulating numbers seems to be universal among both geologists and geophysicists.

**Tonal memory . . .** Evidently an ear for music is an attribute to oil discoverers, for the ability to remember tunes was revealed by these tests to help in those activities having to do with sound and electricity. It was found to be especially prevalent among the geophysical group.

**Subjectivity . . .** Investigators discovered that subjective attitudes are common among all geologists; it is an aptitude quite common among all those performing specialized jobs.

**Accounting aptitude . . .** Those geologists destined for executive and administrative positions are possessed of clerical and statistical aptitudes of an accounting nature.

**Aptitude for ideas . . .** Surprisingly enough, at the bottom of the prevalence list is creative imagination, a measurable aptitude that grows through childhood until we are 14 or 15 and thereafter remains unaltered. Offhand, one would think creative imagination a top requirement in geology, especially in view of some of the structure maps one sees occasionally.

And lest the opening statement on this page create too much furor and violent dissent, it must be pointed out that the percentages apply to tests made in luncheon meetings of only three large geological societies; there is, therefore, plenty of room for doubt. The record of oil discovery chalked up by these three groups would indicate that the ambitious oil operator will do well to seek out a right-eyed geologist with southpaw leanings.

And if you possess all 11 of the geological aptitudes, you'd better get into the consulting field at once!

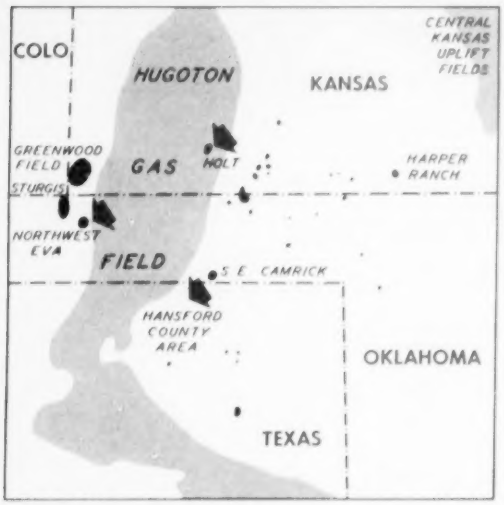


Fig. 1—Three areas of new lower Missouri series production, Northwest Eva, Holt pool, and Hansford County, in the Hugoton embayment are indicated by arrows.

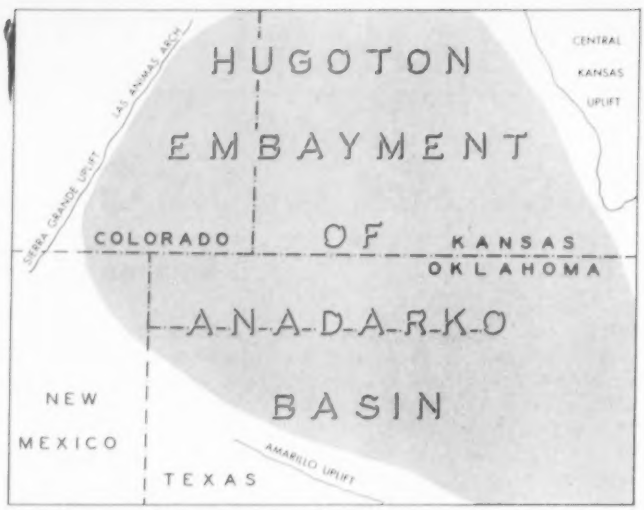


Fig. 2.

### The Hugoton Embayment . . .

**The Hugoton embayment of the Anadarko basin extends northwestward from the Texas Panhandle to Bent County, southeastern Colorado. The embayment is flanked on the west and northwest by the northeast-trending Las Animas arch. The Las Animas arch separates the embayment from the Denver basin. The Central Kansas uplift flanks the embayment on the northeast.**

**The maximum thickness of Pennsylvanian rocks penetrated by wells in the embayment is about 2,700 ft. Rocks of Pennsylvanian age in the area show a marked change of facies from limestone and shale sequence (marine shelf) westward to sandstone and shale sequence of mixed continental and nearshore marine facies.**

# Three Discoveries Spur Search for Pennsylvanian Oil In Hugoton Embayment

**by John C. McCaslin**

THE search for production in Pennsylvanian rocks in the Hugoton embayment of the Anadarko basin is gaining momentum as a result of three significant discoveries in widely separated areas in recent months.

Important new Pennsylvanian strikes have been recorded in the Texas Panhandle, southwestern Kansas, and in the Oklahoma Panhandle. Production at each of the new discoveries is from the lower Missouri series.

#### Recent Discoveries

**Texas Panhandle . . .** Hansford County is the current hot spot in Pennsylvanian exploration and development in this area of the embayment (see Fig. 1).

Since late in 1953 two new producing areas have been opened in the county, one with Douglas sand production, the other with Morrow sand wells. Humble Oil & Refining Co. 1 Jackson was the first Pennsylvanian strike. It flowed up to 6,000 M.c.f. of gas per day on potential test of Douglas sand perforations at 4,967-5,000 ft. This highly important test found its production 2,000 ft. below regular Hugoton field production, 10 miles northwest. The well opened a new pay for the Texas Panhandle.

Humble 1 Wilbanks, 3 miles northwest of Hansford, and west of the 1 Jackson, was potentialed in February as a 1-mile south confirmation and extension to gas production opened at Humble's 1 East Gruver unit, which was completed for 26,500 M.c.f. of gas per day from the Douglas sand. The 1 Wilbanks flowed 3,800 M.c.f. of gas per day with an unestimated amount of distillate on 3/8-in. choke.

In the same area, Humble 1 Collier was completed as a small oil discovery in March. This Douglas strike is located 4 miles southeast of Hitchland in northwestern Hansford County. The 1-B Collier was completed in the same month for 14,100 M.c.f. of gas per day from the Douglas.

Also in Hansford County, The Texas Co. 1 Blakemore opened a new Morrow (basal Pennsylvanian) gas-producing area earlier in the year. A flurry of drilling activity has been noted recently in and around both these new Hansford County producing areas.

**Southwestern Kansas . . .** Cities Service Oil Co. opened the first Pennsylvanian gas reservoir beneath vast Hugoton gas field in Seward County early in 1954 (see Fig. 1).

Holt pool's discovery well flowed at the rate of 17,000 M.c.f. of gas per day from the lower Topeka limestone at a depth of 4,200 ft., much deeper than

the regular Hugoton Permian Chase Group gas pay, which is normally found at 2,700 ft. Nearest Topeka production is in Greenwood gas field, 45 miles to the west.

Greenwood field, the biggest Topeka-Lansing producing area in the embayment, is over 3 years old, and is one of the most rapidly expanding gas fields in the entire Mid-Continent region. Recently the field was extended into Baca County, Colorado, opening first gas production in the Colorado portion of the embayment. The field has been established along an 18-mile strip of the Kansas-Colorado border. Three wells have been completed in Baca County.

Morton County, Kansas, has 13 operations under way at the present time in the Greenwood area. The highly active Seward County area on the east side of Hugoton field has eight wells in progress, while Clark and Meade counties to the east have four and two, respectively.

Eastern Clark County has a big producing area covering several sections as a result of the expansion of new Harper Ranch pool, opened last year at United Producing Co. 1 Harper. The discovery well flowed 6,000 M.c.f. of gas per day from Des Moines-Marmaton perforations. This pool is about 7 miles north of Harper County, Oklahoma.

**Oklahoma Panhandle . . .** The most recent new Pennsylvanian find in the embayment was in Texas County, Oklahoma.

United Carbon Co. opened first gas production from the Topeka lime in the Oklahoma Panhandle at 9 Kelley, in new Northwest Eva pool (see Fig. 1). The well gaged 2,700 M.c.f. of gas per day from perforations at 2,933-46 ft. after acidization. A 20-minute open flow test after the well was shut in for 72 hours gaged a flow of 5,200 M.c.f. per day.

Northwest Eva pool has six oil wells producing from the Morrow sand (here called the Kelley sand). One gas well in the field produces from the Kelley, and one from the Keyes (basal Morrow). There is no outlet as yet for the gas production, but the oil is moved out by truck.

This field was opened last year by United Producing Co. The discovery well was completed for oil in the Morrow sand. Oil is 37°-38° gravity. Northwest Eva lies about 4 miles east of Cimarron County's Sturgis gas area, and Hugoton Permian gas production lies about 8 miles to the east. The pool opened first oil production in Texas County. There are eight operations under way in the area currently.

| HUGOTON EMBAYMENT STRATIGRAPHIC COLUMN | | |
|---|---|---|
| PERMIAN | | GUADALUPE |
| | | LEONARD |
| | CHASE | * WOLFCAMP (Brown dolomite) |
| PENNSYLVANIAN | | VIRGIL |
| | | * MISSOURI (Topeka-Lansing, Douglas) |
| | | * DES MOINES (Marmaton) |
| | | * ATOKA |
| * Oil and gas production | | * MORROW (Keyes, Kelley, Morrow sand) |

**Fig. 3—Generalized stratigraphic column of the Hugoton embayment. Pennsylvanian production is found in Missouri, Des Moines, Atoka, and Morrow age rocks. Permian production is found in the Chase Group and in the Brown dolomite in the Texas Panhandle. Reference: Maher & Collins, U.S.G.S., Oil and Gas Investigations, Map OM 135.**

In southeastern Texas County, the new Southeast Camrick oil and gas pool is experiencing a rapid development program. The Texas Co. 1 Eldridge, north offset to the oil discovery well in the pool, is nearing completion. The discovery well, the 1 Flowers-Johnson-Eldridge unit, flowed 192 bbl. of oil per day through choke from Morrow sand perforations. The gas-discovery well in the pool, completed last January, is The Texas Co. 1 Cook. Recently the 1 Blair was treated to flow 1,450 M.c.f. of gas per day on Morrow sand tests. American Gas Production 1 Silsbee is another new producer in the pool, flowing 3,500 M.c.f. of gas per day with some distillate showing.

Good oil production is being found on the east flank of the Sturgis gas area in northeastern Cimarron County in the Morrow and Keyes sands. Oil and gas production now extend about halfway down the eastern side of the county. Northwest Eva, Southeast Camrick, and the Sturgis area pools all have unusually great areal extent.

### Geological Significance

**Missouri series . . .** The Texas Panhandle's Douglas sand discoveries are in the lower Missouri series, as are the Topeka and Lansing strikes in southwestern Kansas where good production is being developed in Morton County's prolific Greenwood gas field, and in Seward County's new Holt pool.

Missouri age rocks are thought to be more widely distributed in the Hugoton embayment than the earlier Pennsylvanian sediments, because the marine limestones of Missouri age are better developed and are more extensive in the area than those of the Des Moines, Atoka, or Morrow.

The three new widely scattered Missouri strikes in the embayment indicate the untold possibilities of deep Missouri series production in the entire four-state Hugoton area of Oklahoma, Texas, Kansas, and Colorado.

**Morrow sand . . .** This sand is 500 to 600 ft. thick in the deeper parts of the Hugoton embayment. It lies unconformably on Chester rocks in the eastern part of the embayment and on Meramec age rocks in the rest of southeastern Colorado. Morrow beds are unconformably overlain by Atokan beds in the embayment.

The Morrow consists of interbedded black shale, green shale, glauconitic and crinoidal lime, and calcareous, glauconitic sand in most of the embayment.

Good development of Morrow sand production on both sides of Hugoton gas field in the Oklahoma Panhandle and on the east side of Hugoton field in Seward County, Kansas, promises that the search for Lower Pennsylvanian production will keep those areas in the exploration spotlight.

## APPALACHIAN AREA

### WEST VIRGINIA

In Jumping Branch district, Summers County, West Virginia, United Fuel Gas Co. 1-6788 J. Sanford Lilly, deep rank wildcat test, elevation 2,633 ft., recorded the Oriskany sand at 7,943 ft., and is drilling at 7,953 ft. The Onondaga had been previously reported at 7,880 ft. Middle Fork district, Randolph County, Bobray Exploration Co. 1 Chester C. Roush, elevation 2,407 ft., is shut down at 1,600 ft. The Bayard sand was at 1,488-1,505 ft., gas at 1,494 ft., testing 13,000 cu. ft. P. C. McKenzie Co. 1 Elk Horn Coal Corp., is drilling at 1,922 ft. Licking district, Tucker County, Snee & Eberly 1 W. H. Blair, elevation 1,816 ft., are running 7-in. casing at 4,518 ft. The Onondaga was reached at 4,502 ft. In St. George district, Natural Resources Corp. 1-2 Tucker County Court, is at 5,335 ft.

### OHIO

A small rotary was moved in at Kyger Creek in Addison Township, Gallia County, and has drilled three wells through the second Berea sand. This sand has a low permeability and responds well to fracturing, making the prospect of small oil and gas wells in the area good.

A ¼-mile stepout, Mutual Oil & Gas 1 (4) W. L. Melick, Section 19, Jackson Township, Knox County, made 60 bbl. and 170,000 cu. ft. in 24 hours after fracturing. Clinton sand was reported at 2,979-3,030 ft.

Doudna et al moved ½-mile east for their 3 Mary Graber, Section 18, Canaan Township, Wayne County. Clinton sand at 3,245-3,257 ft. made 30 bbl. in 24 hours after fracturing.

## ILLINOIS

In Effingham County 2 miles from other wells Partlow and Cochonour 1 Trustees of Lucas Township School District, NE NW SW 11-6n-6e, is pumping 166 bbl. of oil per day from the McClosky lime after

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acidization. The well is 10 miles south of Effingham.

## LOUISIANA

### NORTH LOUISIANA

### March Discoveries

Two new discoveries were completed in North Louisiana in March. A new gas pool opened in Bienville Parish, and a new oil discovery was chalked up in Concordia Parish.

Placid Oil Co. 1 Southern Advance Bag & Paper Co., Inc. et al Unit A-1, 8-15n-5w, opened Liberty Hill gas field in Bienville Parish. The well flowed 6,000 M.c.f. of dry gas per day through ⅝-in. choke from perforations in the Travis Peak at 8,454-70 ft. (A on map).

In Concordia Parish Carter Oil Co. 1 Graham, C SW SW 45-5n-9e, about 1 mile northwest of production in Deer Park field, but separated by a dry hole, was completed flowing 60 bbl. of oil per day through 5/64-in. choke from Wilcox perforations at 6,023-29 ft. (B on map.)

### SOUTH LOUISIANA

### Allen Parish New Pay Discovery Potentialed

Sun Oil Co. has run potential tests at 2 Chachere, new oil-pay strike in Allen Parish's Kinder field.

The discovery flowed 190 bbl. of 47.7°-gravity oil per day plus 322 M.c.f. of gas on 8/64-in. choke from perforations at 8,062-66 ft. The well is in 25-6s-5w.

### Ascension Well Completed For Gas-Condensate

The Texas Co. and Temple Hargrove et al have completed 1 McCarver Unit, pushing Darrow field production about 1 mile to the south in Ascension Parish.

The well gaged 68 bbl. of distillate plus 2,455 M.c.f. of gas per day on 12/64-in. choke. It spots in 50-10s-2e.

## MISSISSIPPI

**Black Warrior basin . . .** Honolulu Oil Corp. 1 Davis, 22-12s-14, northeastern Calhoun County, is testing.

It is now being flowed on ⅛-in. choke.

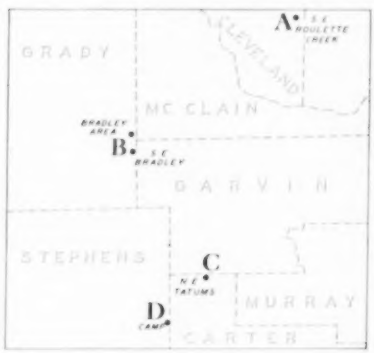
The wildcat flowed gas on two drill-stem tests of open hole from 3,274-3,325 ft. It was swabbed in and flowed at the estimated rate of 1,100 M.c.f. of gas per day on ¼-in. choke. Operators may decide to fracture to increase the rate of flow.

## OKLAHOMA

### Stephens Discovery Finaled In Pickens

Mack Oil Co. 1 Oxford, NW NW SW 26-1s-4w, pumped 30 bbl. of oil per day from the Pickens sand at 5,110-44 ft. to become a new discovery between Sholem Alechem and Velma fields.

The linking space between the two big producing areas is shrinking fast as operators continue drilling up the area to the east of the 1 Oxford. Clyde King, Jr., Russell Cobb, Jr. 1 Strachan, SW SE SW 25, swabbed 300 bbl. of oil in 24 hours and is on the pump, while the 1 Tyson, SE NE NE 36 was completed for 192 bbl. of oil per day. Jake L. Hamon and E. L. Co. 1 Dixon, SE SE NE 36, was finaled for 84 bbl. of oil in 2 hours.




**Johnson and Gill et al have extended contract at 3 Capehart, SE SW SE 14-8n-1e, Southeast Roulette Creek pool in Cleveland County (A on map). Operators got commercial oil shows with water in the second Wilcox sand. They will deepen to test the Tulip Creek. Phillips Petroleum Co. has a new pay discovery in Grady County's Bradley area at 1 Steve, SE NE 35-5n-5w with indicated production from the Bromide below 12,600 ft. (B on map). British-American Oil Producing Co. has proved a new productive location at Southeast Bradley pool's new northeast extension play. The 2 Burkes has shown for Springer production in the C NW SE 12-4n-5w (B on map). Carter Oil Co. 1 Freeman heirs, SE SE SW 6-1s-2w Northeast Tatums field well in Carter County, was swabbed at the rate of 6 bbl. per hour on 11-hour test (C on map). Continental Oil Co. has a new Tussy producer completed in Camp field at the 18 Wallace, SE NE NE 18-2s-3w (D on map). The well flowed 600 bbl. of 28.8°-gravity oil per day through 24/64-in. choke.**

### Holdenville Play Gets High Flowing Well

H. L. Berkey 1 Harjo, stepout test near Holdenville pool, NW SE SE 6-8n-9e, Hughes County, flowed 75 bbl. of new oil in 1 hour through casing following fracture treatment of the Booch sand, promising further extension of the drilling program in the area.

The well lies southeast of the southernmost well in Holdenville pool, a 2-well field opened in 1946. An intensive drilling play is currently going on about 1½ miles south and southeast in East Holdenville and Grief Creek pools. East Holdenville and Grief Creek are now connected.

### New Lincoln Pool Has Another Well

New Southwest Mount Vernon pool in Lincoln County has a new well assured at C. L. McMahon, Inc. 1 Hager, NW NE SE 16-15n-3e.

Recovery on a drill-stem test in the lower Skinner sand at 4,264-77 ft. was 830 ft. of oil and 10 ft. of oil-cut mud.

## KANSAS

### Second Pratt Strike

Lario Oil & Gas Co. is testing Lansing oil shows at another indicated discovery in southwestern Pratt County. The 1 Eurbank estate "A" NE SE NW 30-28s-14w, 3 miles south of Cullison, is 6 miles northwest of the recent 1 Shriver discovery.

Testing continues at the 1 Shriver, NW SW SE 12-29s-14w, 2 miles north of Coats pool, after swabbing 44 bbl. of oil in 6½ hours in the Simpson.

### Pratt Discovery Will Have Dual Completion

Lario Oil & Gas Co. 1 Shriver, NW SW SE 12-29s-14w wildcat 2 miles north of Coats pool in southern Pratt County, is slated to complete in both the Lansing and Simpson.

On a Lansing drill-stem test at 4,307-41 ft. the well gaged 3,120 M.c.f. of gas and flowed oil in 15 minutes. Recovery on a Simpson drill-stem test at 4,560-4,609 ft. was 2,625 ft. gassy oil and 40 ft. oil-cut mud.

### Significant Strike Reported in Morton

Stanolind Oil & Gas Co. and J. M. Huber Corp. 1 U.S.A., C SW 29-34s-43w, Morton County, is reported to be a possible new oil discovery in the greater Greenwood Topeka gas field area of the Hugoton embayment.

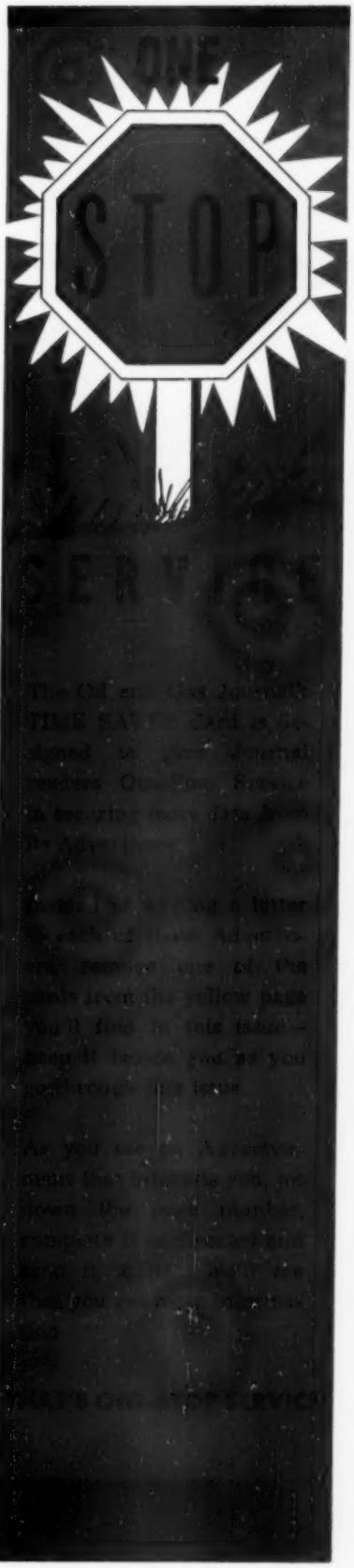
A test of the upper Morrow at 4,191 to 4,204 ft. recovered gas in 5 minutes and gaged 119 M.c.f. It was followed by 1,475 ft. of 40°-gravity oil.

The Morrow is of Pennsylvanian age. Greenwood field production is from the Topeka-Lansing, also Pennsylvanian. The indicated strike is 6 miles due north of Keyes (basal Morrow) gas field in Cimarron Countty, Oklahoma.

## MICHIGAN

Ford Oil Co. was testing a show of gas from the Trenton, coming through a hole full of water, at its 1 Potter & Stephayn, SW SW NE 5-4s-13w, Porter Township, Van Buren County.

This test, an older Traverse oil producer in Lawton pool, being deepened to the lower horizons, is the first Trenton objective well to be drilled in this field. Well is presently bottomed out in the Trenton at 2,680 ft. Operator made an attempt to test gas show with



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2-in. tubing set on a packer, but packer failed to hold. Present plans call for running larger tubing, probably 3-in. on a packer in an attempt to dry up hole to test this gas show.

Top of Trenton was logged at 2,667 ft. and porosity showed in the upper part of this section, but the gas did not show until drilling had approached the present total depth. A cable tool fishing job, now cleaned up, delayed operations for about 2 weeks.

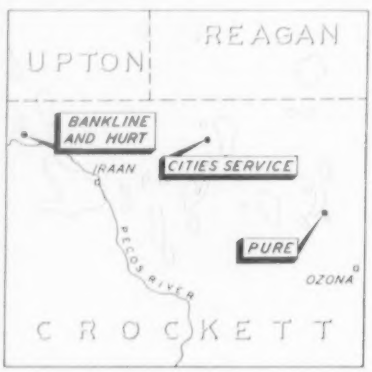
# TEXAS

### WEST TEXAS

## Crockett County Lists Three Discoveries

Crockett County was the center of attention last week, where one discovery was completed and two continued testing.

The finished well is another Strawn discovery, or long south extension, on the west side of shallow production in World field. Cities Service Oil Co. 1-C Shannon, in 19-O-EL&RR Survey, placed sample-top of the Strawn at 8,134 ft., made several flowing tests until water was picked around 8,213 ft., then completed from perforations at 8,190-8,204 ft. Daily potential, based on a 6-hour gage, was 1,002 bbl. of 46° oil, through 32/64-in. choke.




Pure Oil Co. 35 Vaughn, Ellenburger discovery about 2 miles southeast of Vaughn field, (corrected location from previous week's report), had a possible 158-ft. pay section. Top of pay was 7,585 ft., minus 4,976 ft., which was 1 ft. into the Ellenburger. First test recovered a hole full of oil and first flowing oil came on a drill-stem test between 7,667-93 ft. Three hourly gages at this interval were 21.9, 14.5, and 18.3 bbl. of oil through 1-in. chokes.

Further coring showed pay to 7,743 ft., and a test between 7,718-43 ft. had oil in 49 minutes. In 3 hours, the well made 142 bbl. of oil.

Southeast of Tippett field, Bankline Oil Co. and Hurt Oil Co. 1-14 Forrestal has drilled additional pay, now identified as Wolfcamp detrital. Additional drill-stem tests were from 6,287-6,326 ft., which flowed oil at the rate of 75 bbl. an hour; and from 6,326-62 ft., which developed mud with no shows. Operators were drilling ahead below 6,376 ft. Over-all pay section indicated was 168 ft.

**Ward County . . .** Magnolia Petroleum Co. 1-University "B," Delaware discovery 7 miles northwest of Pyote, continued testing. Through casing perforations at 5,014-17 ft. the well flowed 4 bbl. of distillate in 8 hours through 12/64-in. choke. Gas-oil ratio was around 92,500 cu. ft. and gravity was 62°. Oil-water contact was at around 5,112 ft.

Gulf Oil Corp. 319 O'Brien, deep exploration in North Ward-Estes field, developed water blanket and mud with no shows on drill-stem test in dolomite from 15,377-15,455 ft. Lowest formation marker reported was the Mississippian at 11,940 ft. and lowest section showing oil on drill-stem test was from 13,784-13,894 ft. Recovery from that interval included 1,180 ft. of oil-cut mud.

**Dawson County prospect . . .** Joe A. Humphrey 1 Billingsley, in the southeastern corner of the county, has made two successful drill-stem tests in Pennsylvanian lime. First test at 9,157-90 ft., recovery was 30 ft. of oil, oil-cut mud and salt water. Second test at 9,190-9,215 ft. had flowing oil in 26 minutes. There was no water on this test and the flow was at the rate of 33 bbl. of oil an hour for 6½ hours. Location is about 5½ miles west of the new and prolific Oceanic-Pennsylvanian pool in northern Howard County.

**Midland County . . .** Seaboard Oil Co. 1 Tillman, 2 miles north of Midland, reported a drilling break at 12,570 ft., where the well started kicking, then flowed around the drill pipe, making drilling water with shows of oil and gas. Operators pulled pipe to make a test and the well again flowed through casing, making a heavy flow of sulfur water with a trace of oil. Operators believed the water was coming from a previously tested section up the hole

### EAST TEXAS

## Old Well Makes Gasser In Rusk County

Carter-Jones Drilling Co. 1 Turlington, Pettit limestone gas discovery 2 miles northeast of Tatum, was waiting on official potential after flowing an estimated 35,000,000 cu. ft. of gas a day from perforations at 6,830-35 and 6,837-42 ft. The well was formerly drilled dry by The Texas Co. Nearest production is 3 miles north in South Hallsville field.

**Harrison County extension . . .** Stanolind Oil & Gas Co. 1 Bates, 2½ miles west of Blocker field, finished as a gas well making 3,099,000 cu. ft. per day. Production was from perforations in the Page zone of the Travis Peak at 6,555-60 ft. Gas-oil ratio was 18,510 cu. ft.

Hunt Oil Co. 1 Brooks, wildcat 2 miles northwest of Blocker field, was reported testing in the Travis Peak at 6,780-94 ft., with no details released.

**Franklin County new pay . . .** Humble Oil & Refining Co. 1 Gibson, Cornersville pool test 8 miles north of Winnsboro, has added a new pay to the area, in the Rodessa. The well flowed 242 bbl. of oil a day through 11/64-in. choke from perforations at 7,753-59 ft.

### SOUTHWEST TEXAS

## Oil Recovered on Tests At Dimmit County Wildcat

Stanross Production Co. is coring below 5,171 ft. at 1 George W. Hendrichson, Dimmit County wildcat northeast of Valley Wells. Oil and gas-cut mud were recovered on drill-stem test of the Olmos (Upper Cre-

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taceous Gulf Series). Recovery was 25 ft. of oil and gas-cut mud.

TEXAS GULF COAST

## Potential Due at Jackson Discovery

Holmes Drilling Co. is making production tests at 1 Lorentzen, oil discovery 6 miles south of Edna in Jackson County.

The strike is in J. J. Linn Survey, A-213, Lot 1, C. W. Hahl Subd. of Harwood-Burns Ranch. It is perforated from 5,300-5,306 ft.

## Open-Flow Potential Taken at Liberty Well

Eddy Refining Co. has run open-flow potential at 1 Cornell College, originally drilled to 11,631 ft. last year and just opened from Cook Mountain perforations at 11,542-563 ft. The Liberty townsite area well, Liberty County, gaged 20,000 M.c.f. of gas per day plus 54.8°-gravity distillate. Gas-liquid ratio of 40,000:1 and a shut-in pressure of 5,164 psi. was reported.

## Ramsey Flank Well Is Finaled In Colorado

Humble Oil & Refining Co. has completed 1 Birdwell et al on the east flank of Ramsey field in Colorado County.

The strike flowed 1,625 M.c.f. of gas and some distillate. The Ramsey area was opened by Cities Service Oil Co. in 1943 and has uncovered five gas-distillate sands in the Wilcox from 8,329-35 and 8,938-65 ft. There were 11 gas and distillate wells on production as of March 1952.

## New Oil Pay at North Buna in Jasper

American Republics Corp. and Houston Oil Co. of Texas found a new pay in Jasper County's North Buna area at 1 John D. Johnson fee after a rework job.

The first Yegua oil discovery flowed at the rate of 59 bbl. of oil through 9/64-in. choke from 6,709-14 ft.

NORTH TEXAS

## Cambrian Defined on West Flank of North Dora

Skelly Oil Co. 4-B Boyd has been completed as a good flowing well in North Dora field, but the well did not make commercial production in the Cambrian section.

Completion was made through ¾-in. choke and perforations in the Ellenburger at 6,124-88 ft. Potential was 784 bbl. of 47° oil a day, with no water. Location is ¾ mile west of Cambrian producers. Ellenburger top was picked at 6,122 ft. and top of the Cambrian at 6,352 ft.

**Kilroy field development . . .** Humble Oil & Refining Co. 1 NT-TXL, southwest offset to the field discovery, has been completed for 93 bbl. of oil a day from Cambrian pay at 6,097-6,114 ft.

Seaboard Oil Co. and Continental Oil Co. 1 Jordan, south offset to the discovery, gaged 111 bbl. of oil in 12 hours through ¾-in.

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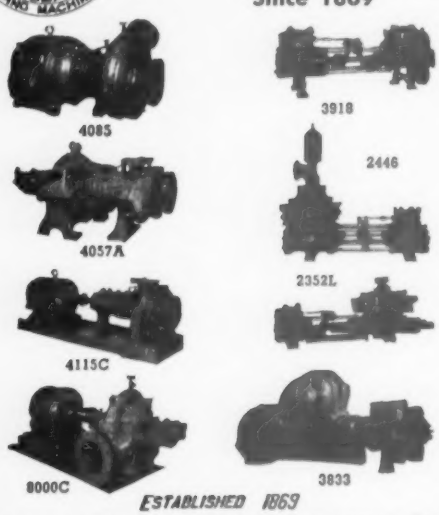


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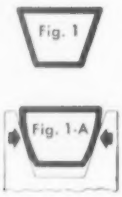


Take *any* V-belt that has *straight* sides (Fig. 1). Bend that V-belt while you grip its sides with your fingers. You will *feel* the sides *bulge out* (Fig. 1-A). Clearly, that out-bulge forces the belt to press *unevenly* against the V-pulley—and this *concentrates* wear at the points shown by arrows (Fig. 1-A).

### Now bend a Gates Vulco Rope with CONCAVE SIDES (Fig. 2)

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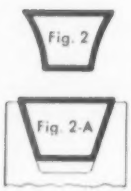


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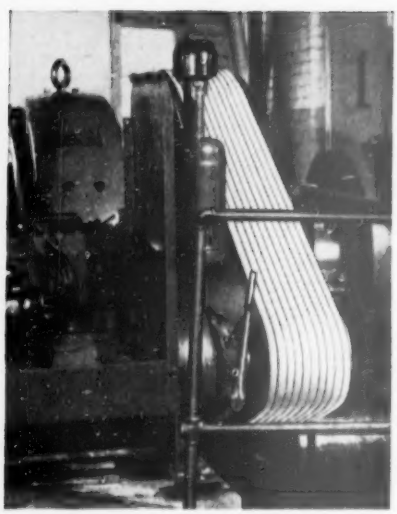

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choke, from Cambrian pay at 6,092-6,112 ft. The well drilled into pre-Cambrian at 6,445 ft.

TEXAS PANHANDLE

## Sherman County Gas Discovery is Completed

Humble Oil & Refining Co. 1 Stratford Gas Unit, 7 miles northwest of Stratford and about the same distance northwest of Hugoton gas field, rated a daily potential of 21,500,000 cu. ft. of gas. Pay section at 3,273-3,464 ft. is the Cisco, which was topped at 3,160 ft. Pre-Cambrian granite was entered at 6,085 ft.

This well also swabbed 11 bbl. of oil in 11 hours from a Mississippian section at 4,855-77 ft.

**Roberts County . . .** Gulf Oil Corp. has apparently ended its extensive testing at 1 John Haggard, deep test in Quinduno field. This well opened the field in the Pennsylvanian in 1952, but was re-entered later to explore the lower formations.

Total depth was 12,597 ft. A new potential will be made from Pennsylvanian pay at 7,248-55 ft. Original completion was for 125 bbl. daily at 6,736-43 ft.

# CANADA

## Light Oil Found At Greencourt Wildcat

Canadian Gulf Oil Co. has found some light-gravity oil in the D2 zone of Devonian at its wildcat in the Greencourt area of Alberta. That same exploratory driller has previously found some medium-gravity oil in the detrital section above the Mississippian.

The well, Gulf 5-14 Blue Ridge, LSD 5, 14-58-8w5, is 68 miles northwest of Edmonton and 9¾ miles east-northeast of the Fina-Cities Service 6-7 Greencourt Mississippian oil discovery well. A 3-hour drill-stem test was run from 6,021-43 ft. Natural gas flowed at rate of about 1,000,000 cu. ft. daily, while oil reached the surface in about 1½ hours. When pipe was pulled it was found to contain approximately 900 ft. of clean oil and 450 ft. of salt water. It is not as yet known how much oil pay zone is present above the indicated formation water, nor is it known whether or not this venture will result in a commercial D2 oil producer.

Previous test, in the detrital, from about 4,705-12 ft., for 1½ hours, flowed gas at rate 150,000 cu. ft. daily, wet gas in 25 minutes, and recovered 50 ft. of oil and 350 ft. of oil-cut mud, no water.

**West Olds area . . .** Another Mississippian gas discovery, along with some condensate, has been recorded in the West Olds area of southern Alberta, about 54 miles north of Calgary. This venture, being drilled by Shell Oil Co., lies about 11½ miles north-northwest of the Great Plains-Canadian Superior et al 16-13 Elkton prolific Mississippian wet gas strike.

The new discovery came at Shell A-16-15 West Olds, LSD 16, 15-33-4w5, 6½ miles southwest of the Shell 1 Westerdale light gravity oil discovery well and slightly less than 6 miles southwest of Shell A-15-33 Westerdale-C&E abandonment. Discovery was recorded during a 70-minute drill-stem test from 8,697 to 8,750 ft., using a 1,640-ft. water cushion. Natural gas flowed in 20 minutes, at maximum rate 2,500,000 cu. ft. daily and pipe recovery consisted of 480 ft. of gas-cut water cushion and 360 ft. of gassy condensate and mud. Gravity of the condensate is estimated at 42°, Shell reported.

Next test in the Mississippian, was from 8,747 to 8,773 ft. for 65 minutes, using a 1,760 ft. water cushion. Pipe recovery was 100 ft. of gas-cut mud with a trace of condensate. There was no gas flow reported. Crew was running log at 8,818 ft. at last report, preliminary to deepening.

This venture, last month had obtained a showing of gas and oil-cut mud in the lower Blairmore. A 75-minute drill-stem test of the interval 8,474 to 8,571 ft., through ½-in. choke, with a 1,440-ft. water cushion, flowed gas in 55 minutes, at rate too small to measure. Pipe recovery consisted of 450 ft. of gas-cut water cushion and 640 ft. of gas and oil-cut mud.

**Saskatchewan . . .** Rio-Prado Consolidated Oil, Ltd., announced that an encouraging showing of heavy-gravity crude oil has been encountered in the Colony sand at a wildcat venture being drilled by the Pump Oil Syndicated of Toronto, on farmout lands from Rio-Prado in the North Battleford area of Saskatchewan.

The Saskatchewan venture is Rio-Prado 4-8 Mervin, LSD 4, 8-50-19w3, 35 to 40 miles northwest of North Battleford and about 45 miles east of the Lloydminster heavy crude oil region. The Mervin well found good sand development and well saturated cores in the Colony sand interval 1,445 to 1,460 ft. A 1-hour drill-stem test from 1,440-60-ft. yielded a recovery of 90 ft. of oil-cut mud. Gravity of the oil is estimated at 12° to 15°. Rio Prado officials stated. Whether or not this Colony sand section will result in commercial production is not as yet determined, and crew


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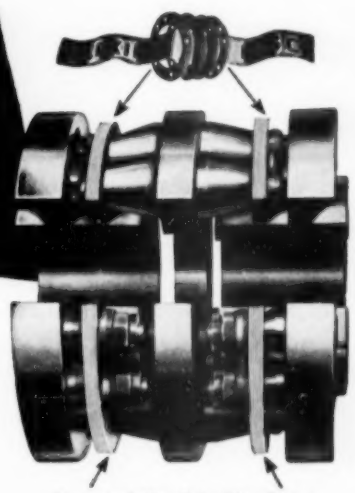

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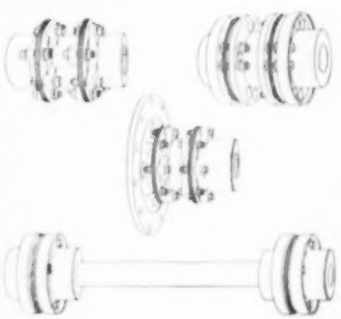

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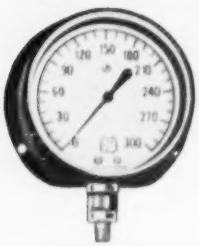

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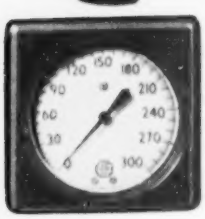

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is continuing to drill ahead. Hole is scheduled to go down as a Devonian test.

Assurance of oil discovery in the Cardium sand come at the Superior et al 10-27 Rocky Mountain House wildcat over the weekend, following a petrofrac treatment of two sections in the Cardium. Both of those zones gave up light-gravity clean crude oil, with no evidence of formation water.

This well is situated in LSD 10, 27-42-8w5. It is on a Crown Reservation, comprised of 23,040 acres. Site of the new discovery is 20 miles south of Pembina Cardium oil producers, 12 miles south of the Los Nietos et al 7-12 Alder Flats wildcat driller, 20 miles north-northwest of Rocky Mountain House and 57 miles northwest of Red Deer.

This well was originally drilled as a 'slim' hole, diameter of that hole being 4¾-in. Because of difficulties encountered in attempts to production test the Cardium in that small diameter hole, it was reamed out to a 6¾-in. diameter hole. Several attempts at drill-stem tests following the reaming, also failed, so backers of the project ran string of production casing for a more thorough test of the indicated productive horizon.

The lower section of the Cardium was perforated from 6,223-27 ft., was given a 300-gal. acid wash, and was swabbed. There was no fluid recovered from the formation. Crew backed up in the hole, and perforated the mid-section, from 6,207-14 ft., with 4 shots per ft. A petrofrac treatment was applied to the formation, and the well gave up 240 bbl. in about 10 hours, of which 54 bbl. was oil from the formation, the balance was input oil.

Latest interval to be perforated was 6,185 to 6,202 ft., with 5 shots per ft. That interval was also given treatment, and the well produced 295 bbl. of oil, including 55 bbl. of new oil from the formation. The balance was input oil.

Later this week, the well was opened to separator and produced 84 bbl. during a 10-hour period. Following that flow test, production for a 23-hour period was 111 bbl. Throughout test, well was flowing by heads every 2 hours. Gravity of the oil is 39.5°.

## KENTUCKY

### EASTERN KENTUCKY

In Elliott County 10S-77 Ballard Lyons has completed 2 Luke Ferguson for 10 bbl. of oil per day from Weir sand 874 to 890 ft. Total depth was 897 ft. Well was Hydrafraced for completion. No. 3 well on the lease is making 1½ bbl. of oil per day and will be fractured for completion.

In the Pike County sector of Big Sandy gas field and located on Marshall Branch, Kentucky West Virginia Gas Co. have completed 6176 Wm. Tackett for 3,500,000 cu. ft. of gas daily from the Mississippian Big lime at a total depth of 2,419 ft. A 15-hour rock pressure recorded 510 pounds.

### WESTERN KENTUCKY

In Union County C. E. O'Neal & Co. I Head et al, 4 miles west of Corydon in 9-O-21, casing has been cemented after a drill-stem test of the lower McClosky lime at 2,674-89 ft. gassed to the surface in 2 minutes and flowed natural in 37 minutes.

H. E. Walton and Roy Pledger are drilling ahead in Henderson County at 1 Latta, 7-P-21, 3 miles west of Smith Mills and 1 mile from production. Recovery on a drill-stem test of 13 ft. of saturated Tar Springs sand was 243 ft. of clean oil, 30 ft. mud-cut oil, 90 ft. of oil-cut mud and no water.

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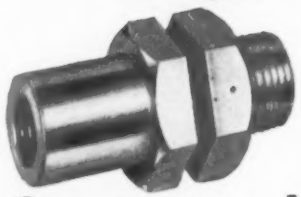

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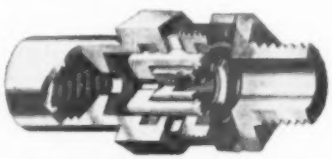

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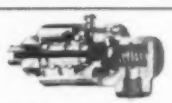

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### MONTANA

### Cabin Creek Confirmation Completed

Shell Oil Co. has reported a completion gage of 259 bbl. of oil and 5 bbl. of water per day at 11-33 NP, SE NW NW 33-10n-58e, second well to be completed in Cabin Creek field, Fallon County. Production is from the Silurian interval 8,312-8,540 ft. It is a northwest offset to the discovery which was completed for 244 bbl. of oil per day from Ordovician after testing for a calculated gage of 4,253 bbl. a day from both Silurian and Ordovician.

Shell's latest completion was through 17/64-in. choke. Tests of Ordovician had apparently commercial oil recoveries, but dual completion was not attempted.

Shell is testing at a third well in the field, Unit 34-33, NW SW SE 33-10n-58e, ½ mile southeast of the Cabin Creek discovery. At latest report the well was flowing at the rate of 226 bbl. per day through 12/64-in. choke from the Ordovician zone 8,922-9,124 ft.

### Tests of Madison Continuing At Richland Wildcats

Sun Oil Co., operator of the 1 Beagle Land & Livestock, NE SW SW 17-23n-59e, in the North Sidney area of Richland County has reported that a lower zone in Madison has been perforated and acidized and tests are continuing. The well has been extensively tested in the interval 9,002-62 ft., and recovered up to 140 bbl. of oil with varying quantities of sediment and water in 12-hour swabbing periods. The well was scheduled as a test to Ordovician, and may yet be continued to the deeper formation, according to the operator, but depending on the outcome of tests now in progress.

At 2 Dynneson, C SW SW 29-24n-58e, second well in the Brorson area of Richland County, Sun Oil Co. and Phillips Petroleum Co. have perforated in Madison and are swabbing. No recoveries have been reported from the latest series of tests. This well also was scheduled as a test to Ordovician . . . a confirmation attempt to the discovery which produced from this formation at 12,508-12,605 ft. It will be deepened if present testing at about the 9,000 ft. level is unsuccessful.

### NORTH DAKOTA

### West Sanish Area Offset Staked

Stanolind Oil & Gas Co. has made location for a confirmation to its Basal Mississippian discovery in the Sanish area of McKenzie County. The discovery was 1 Starr, SW SE 21-152n-94w, found production from a previous nonproductive zone in Mississippian which has been referred to by the operator as "Sanish sand." The second well is 1 New Year Many Ribs, SW NW 28-152n-94w. It is located on temporary 160-acre spacing, as recently authorized by the state industrial commission for new fields.

### Amerada Petroleum Spuds New East Tioga Wildcat

Amerada Petroleum Corp. has spudded a new test east of Tioga pool. The well, 1 Sather, NE NE 34-158n-94w, is in Mountrail County, 2½ miles east of production and about midway on the north-south axis joining two recent discoveries at 1 Rice, NE NW 23-158n-94w, and 1 Lokken, NE SW 2-157n-94w.

### Golden Valley County Wildcat Is Failure

Gulf Oil Corp. will abandon 1 Government-Dorough, NE SW 24-143n-103w, in the Trotters area of Golden Valley County. Total depth was 13,373 ft. The well had shows in several formations, notably in the Mission Canyon (Mississippian), but tests recovered only mud and water. A second test of the area has been located by this operator, however. Gulf will drill a Mission Canyon test in NW NE 2-143n-103w.

### WYOMING

### Sublette County Wildcat Location Reported

General Petroleum Corp. has made location for a wildcat to test Mesaverde about 4 miles northeast of the town of Big Piney in Sublette County. The well is 63-X-21 Bar Cross, NE SW NE 21-30n-112w. It is 12 miles east of gas production in Big Piney field and is on the western flank of the Green River basin.

### Important Big Horn Basin Deep Test Abandoned

Gulf Oil Corp. has abandoned 1 Teeters, C SE NW 28-47n-93w, in the Fourteen Mile


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*Refer to Dept. 164*

**CANNON ELECTRIC**

Unit, Washakie County. The well was drilled to 12,206 ft., and had shows in Phosphoria. After plugging back to 12,180 ft. this formation was acidized and swabbed water with a little oil. It is northeast of Gulf's deep discovery drilled in this area in 1951 and completion for 572 bbl. of distillate in 11 hours, and a flow of sour gas at the rate of 12,000 M.c.f. per day. It is the second well in this general area to fail during the past several weeks.

A third well is drilling in the Blue Ridge Unit, west of Fourteen Mile. Anderson-Prichard Oil Co. has released no data at 1 Ferand, W½ NW NW 33-47n-95w, but has reported the well drilling.

## New Weston County Producing Area Opened

True & Brown and R. H. Fulton have completed Western Empire-Government E-1, C SW SE 2-42n-67w, northwest of Black Thunder production in Weston County for a flow of 800 bbl. of oil per day. Production is from perforations in Newcastle at 7,436-47 ft.

Located northwest of the producing trend at Clareton-Black Thunder, the well is about 4 miles west of previous production, and is separated from previously producing areas by several failures.

### SOUTH DAKOTA

## Offset to Harding County Discovery Now Testing

Shell Oil Co. has recovered gas-cut mud and water on test of an offset to its discovery in the Buffalo area of Harding County. The discovery was the state's first producer. The second well, 32-16, SW NE 16-21n-4e, topped Red River (Ordovician) at 8,513 ft. Test of the zones 8,868-85 and 8,687-8,715 ft. recovered oil and gas-cut mud and some oil and gas-cut water with oil content ranging up to 40 per cent. Recoveries were rather similar to those on tests of this formation in the discovery. Shell is still testing with total depth 8,720 ft.

### COLORADO

## Adena - South Discovery Completed

Sunbeam Oil (Eddie Fisher) has completed 1 State, NE NE SW 35-1n-58w, south of the Adena field in Morgan County for a flow of 48 bbl. of oil per hour on ¾-in. choke. The discovery is 2 miles south of previous production. Perforations are in the "J" sand interval 5,897-5,902 ft. Two other wells in the area are near completion, with tests near or now in progress.

## Failure Abandoned At Alamo Dome

Lewis Drilling Co. has abandoned 1 Major Ranch, SW NW NE 2-28s-68w, Huerfano County at 5,985 ft. At this depth the wildcat was reported 2 ft. in Dakota. A good show of oil was found in cores of Codell at 5,429-59 ft. Circulation was lost at top of Dakota, and after use of 600 bbl. of mud in an attempt to regain circulation, heaving shale caused loss of hole, and the well was abandoned. The operator has announced no immediate plans for further drilling.

# CALIFORNIA

## Wildcat to Test North Flank of New Fresno Pool

Guijarral Hills' budding North Leda pool received two new producers and a ¾-mile extensioner was staked on its north flank. Outcome of the latter, Los Nietos Co., Oper. 87 Guijarral Service in SE SE 22-20s-16e, is expected to shed considerable light on the Fresno County pool's importance.

Standard Oil Co. of California 85 27F was completed ¾-mile south of the new wildcat and almost ½ mile northwest of the discovery. It flowed 37°-gravity crude through a 28/64-in. choke at a 940 bbl. daily rate during a 16-hour test period, producing from the Leda sand at 8,575-8,650 ft. Union Oil Co. 8 Spieler, a southwest offset to the discovery, flowed 989 bbl. daily on a 9-hour test through a 30/64-in. choke. Union had two wells drilling, one a northeast offset to Standard 85 27F. Standard was drilling on 87 27F.

## Second Carneros Well Added to Elk Hills

Standard Oil Co. of California, operator of the Elk Hills Naval Petroleum Reserve, completed 515 29R as the second producer from the Carneros zone of middle Miocene. The test was ½ mile east of the discovery in the western portion of the Kern County field, or in NW SW 29-30s-23e. It flowed 57.5°-gravity condensate at a 238 bbl. daily rate. Production was through a 15/64-in. choke and

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from the interval 9,050-9,230 ft. After undergoing a production test for 30 days the extensioner will join the other shut-in Miocene wells.

## Deeper Edison Pay Tested

Standard Oil Co. 78-8 Jeppi-Camp on a formation test at 6,000 ft. indicated it might add a deeper pay to the Jeppi area of the Race Track Hill field near Edison. After topping the Chanac at 2,610 ft., Jeppi at 3,047 ft., and the Nozu (middle Miocene) at 4,913 ft., the test at 5,983-6,033 ft. resulted in the recovery of 3,140 ft. of fluid. Of this about 20 per cent was 40°-gravity crude. Standard 47-8 Jeppi, two locations northwest, is producing from Jewett and Pyramid Hills sands (lower Miocene) at 5,915-50 ft.

## WILDCAT COMPLETIONS

### SOUTHWEST TEXAS

Atascosa County: E. V. McCright 1 Schroeder, M. J. Harris Sur. 10, A-1221. Dry. TD 2,025 ft.

Duval County: The Texas Co. 1-A DCRC NCT-13, E. J. Corkill Sur. 64, A-1945. IPP 92.5 BOPD, 20.6°, perforations 1,324-38 ft. TD 2,660 ft. (New field—East Casa Blanca.)

Hidalgo County: Houston Oil Co. of Texas and American Republics Corp. 2 Bell, Lot 6, Blk. 40, Homeville Association Subd., Porcion 76. IP 3,100 M.c.f. daily with 42 BC per M.M.c.f., perforations 8,775-90 ft. TD 9,791 ft. (New pay in Tabasco field.)

Jim Hogg County: K. D. Owen 1-E Carlos Palacios, Blk. 3, Homer Tyson Subd., El Randada Grant. Dry. TD 3,411 ft.

Jim Wells County: Lyman Damascus Operations 5 Erck, Sec. 15, Richard King Farm Lots. IP 127.1 BOPD, 13/64-in., 33.1°, perforations 4,818-37 ft. TD 4,999 ft. (New pay in Captain Lucy field.)

W. B. Osborn 2 Goldapp, Blk. 4, LaVaca Grant, A-166. IP 7,400 M.c.f. daily, open-flow potential, GOR 29,200-1, 55.1°, perforations 8,194-8,212 ft. TD 12,500 ft. (New field.)

McMullen County: Sunray Oil Corp. 1 Renshaw Unit, AB&M Sur. 53, A-28. IP 1,950 M.c.f. daily, open-flow potential, GOR 18,000-1, 55°, Queen City 6,068-85 ft. (perforations). TD 8,655 ft. (New pay in North Hostetter field.)

Texakota Oil Co. 1 Cremine, BS&F Sur. 3, A-143. Dry. TD 2,079 ft.

Nueces County: H. H. Howell and George E. Farenthold 1 Bluntzer, Tract G, Share 1, Bluntzer Partition. Dry. TD 5,610 ft.

San Patricio County: S. H. Howell 1 Bluntzer, Blk. 84, San Patricio de Hibernia Grant, A-30. IP 148 BOPD, 8/64-in., 41°, perforations 6,115½-17 ft. TD 6,512 ft. (New field—Mary Bluntzer.)

Starr County: Continental Oil Co. 129-A Slick, Sur. 535 (Rincon area). Dry. TD 4,375 ft.

Val Verde County: S. F. Hurlbut et al 1 Bluff Creek Ranch, Sec. 9, Blk. 5, I&GN Sur. Dry. TD 3,482 ft.

Webb County: W. L. Cotton 1 Bruni estate, J. M. Aguilar Sur. 3. Dry. TD 934 ft.

W. L. Cotton and L. G. Shelly 2 Rosa V. de Benavides, Sur. 1087. IPP 17.53 BOPD, 22.8°, perforations 2,327-33 ft. TD 2,395 ft. (New field—Conchudo.)

C. G. Mortimer, Jr., and F. W. Shield 1 Burleson, Blk. 1, CCSD&RGNG 30. Dry. TD 4,518 ft.

Wilson County: Morris Cannan 1 Baptist Foundation, Howard Ranch Subd., Don Gasper Flores Sur., A-13. Dry. TD 6,433 ft.

Zapata County: Raymond P. Elledge, Jr., 1 Trevino, Lot 7, Blk. 4, Mode Subd., Porcion 3. Dry. TD 1,100 ft.

O. W. Killam 1 Martinez, Sur. 275. Dry. TD 2,551 ft.

### TEXAS GULF COAST

Brazoria County: E. Cockrell, Jr., 5 Chilton et al, Austin & Williams Sur., A-145, (Stratton Ridge area). Dry. TD 6,142 ft.

Mac Drilling Co. and King & Heyne 1 Ryan et al, John Bradley Sur., A-45. Dry. TD 10,003 ft.

Fort Bend County: L. H. Freedman et al 1-A T. W. Davis estate, J. J. Dickerson Sur., A-401 (north flank Big Creek dome). Dry. TD 6,550 ft.

Harris County: Reynolds Mining Corp. 1 Furr, Martinez Sur., A-545. IP 128.28 BOPD, ⅞-in., 36.7°, Vicksburg "C" sand 6,470-75 ft. (perforations). TD 9,020 ft. (New pay in South Clinton field.)

Carnes W. Weaver 1 United Home Builders, Inc., W. M. Jones Sur., A-482. Dry. TD 8,515 ft.

Jefferson County: Stanley V. Rush et al 1 Neches, C. Williams Sur., A-59 (in Beaumont townsite). Dry. TD 6,985 ft.

Karnes County: Don F. Tobin and Inca Drilling Co. 1 Johnson, Carlos Martinez Sur., A-6. IP 1,650 M.c.f. daily with 12 BC per M.M.c.f., open-flow potential, perforations 5,707-13 ft. TD 6,242 ft. (New field.)

Superior Oil Co. 1 Mixon, Victor Blanco Sur., A-3. IP 2,418 M.c.f. daily and 37.4 BCPD, 15/64-in., 53.5°, perforations 6,549-55 ft. TD 6,829 ft. (New field.)


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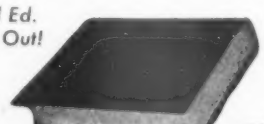

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## WILDCAT COMPLETIONS

Texas Eastern Production Corp. 1 Wuest, Rufus Muncas Sur., A-203. Dry. TD 8,347 ft.

Matagorda County: Trans-Tex Production Co. 1 Kaack et al Unit, W. C. Ewing Sur., A-154. Dry. TD 11,080 ft.

Montgomery County: McAlester Fuel Co. and Goldston Oil Corp. 2 Maurice Hirsch et al, Edward Hall Sur., A-576. Dry. TD 7,450 ft.

Orange County: Kirby Oil & Refining Co. 1 Miller-Vidor, Thomas H. Breece Sur., A-3. Dry. TD 8,103 ft.

Victoria County: Southern Minerals Corp. 1 Buhler, Z. Lanningham Sur., A-250. Dry. TD 5,015 ft.

### EAST TEXAS

Camp County: Pan American Production Co. 1 Mitchell, Benjamin Porter Sur., A-99. Dry. TD 8,501 ft.

Freestone County: O. L. Gragg 1 Gragg Ranch, W. A. Brown Sur., A-77. Dry. TD 4,515 ft.

Great Western Drilling Co. 1 Stubbs, Turner Smith Sur., A-759. Dry. TD 1,308 ft.

Kaufman County: Curtis A. Kinard 1 Daniel, A. Van Hoser Sur. Dry. TD 5,211 ft.

Rains County: Delta Drilling Co. 1 Dowell, A. R. Taylor Sur., A-228. Dry. TD 4,208 ft.

Red River County: B. G. Byars 1 Chapman, H. B. Shaw Sur. Dry. TD 3,324 ft.

Rusk County: Natural Gas & Oil Corp. 1 Gates & Rogers, Fred Blanchard Sur., NW stepout to Minden field gas discovery, 9 miles SE Henderson. Completed as shut-in gas well, no IP reported. Travis Peak pay 7,405-09 ft., TD 7,700 ft.

### TEXAS PANHANDLE

Hansford County: Kimball 1 Dozier, Sec. 174, GH&H Sur. Dry. TD 6,978 ft.

Sherman County: Phillips Petroleum Co. 1 Massive, Sec. 96, T&NO Sur. Dry. TD 3,753 ft.

Wheeler County: Sun Oil Co. 6 Strat test, Sec. 82, H&GN Sur. Dry. TD 3,995 ft.

### WEST CENTRAL TEXAS

Brown County: Mullins & Miller 1 Harris, P. Mangle Sur. 617. Dry. TD 885 ft.

Callahan County: Condor Petroleum Co. 2 Barton, Sec. 9, BBB&C Sur. Dry. TD 1,684 ft.

Coleman County: W. H. McGarr 3 West, John H. Barkley Sur. 701. Dry. TD 2,198 ft.

M. H. Halff 1 Stewardson, Robt Wilson Sur. 334. Dry. TD 1,717 ft.

Guy Mabee Drilling Co. 1 Herring, Dugold McLean Sur. 757. Dry. TD 3,635 ft.

Goy H. Smith Drilling Co. 1 Hickman, J. Scott Sur. 665. Dry. TD 1,900 ft.

Eastland County: James B. Wallace 1 Williams, 40-2-ETRR Sur. Dry. TD 1,205 ft.

Fisher County: Oceanic Oil Co. 1 Pope, T. H. Cosby Sur. 321. Dry. TD 5,805 ft. Elev. 1,864 ft., Caddo 5,804 ft.

Haskell County: Clark & Cowden Production Co. 1 Turner, 26-14-H&TC. IPP 45 BOPD, 39°, Strawn lime pay 4,917 ft. TD 4,955 ft.

Thos. D. Humphrey & Sons 1 Fisher, J. Husband Sur., A-158. Dry. TD 5,352 ft.

Jones County: Hovgard & Fitzgerald 1 Dumler, Sec. 178, BBB&C Sur. Dry. TD 4,200 ft.

Jones & Stasney 1 Huddleston, 36-2-SPRR. Dry. TD 4,903 ft.

Jones & Stasney 1-A Shaheen, 53-15-T&P. Dry. TD 2,255 ft.

Lucerne Corp. 1 Grimes, Sec. 44, D&DA Sur. Dry. TD 2,895 ft.

Elm Oil Co. 1 Carter, 33-18-T&P. IP 144 BOPD, 12/64-in., 40° pay 4,408 ft. TD 4,424 ft.

Nolan County: Cree Drilling Co. 1 Witherspoon, 33-24-T&P. Dry. TD 7,500 ft. Elev. 2,421 ft., Ellenburger 7,382 ft.

C. L. Norsworthy 2 Jordan, 24-1A H&TC. Dry. TD 6,842 ft.

Shackelford County: Dean Bros. 1 Strickland, Sec. 45, BOH Sur. Dry. TD 4,340 ft. Ellenburger 4,325 ft.

Sojourner Drilling Co. 1 Davis, Sec. 220, ETRR Sur. Dry. TD 1,908 ft.

Stephens County: Leatherwood Drilling Co. 1 Hill, 13-2-SPRR. Dry. TD 4,547 ft.

P. W. Pitzer 1-D Pitzer, 16-4-T&P. Dry. TD 2,028 ft.

Aljon Oil Co. 1 Peyer, 38-6-T&P. Dry. TD 1,877 ft.

Stonewall County: Thos. D. Humphrey 1 Taylor, 211-D-H&TC. Dry. TD 6,589 ft.

Taylor County: Fred Goodstien 1 Bell, 42-19-T&I Sur. IP 304 BO in 12 hours, 18/64-in., 42°, pay 4,971 ft. TD 5,754 ft.

S. C. Herring 1 MacBacon, 27-1-SPRR. Dry. TD 4,610 ft.

J. S. Pittman 1 Hester, J. W. Page Sur. 123. Dry. TD 3,047 ft.

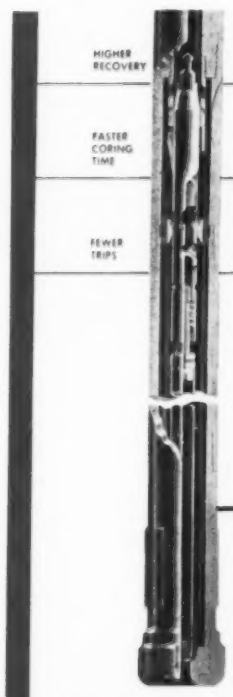
### NORTH TEXAS

Archer County: M. W. Blair 1 Wallace Estill, BBB&C Sur. 1, A-41. Dry. TD 1,550 ft.

Double L Drilling Co. 2 Wolf, 31-4-Clark & Plumb. Dry. TD 1,091 ft.

Morty Freedman 1 Steen, IRR Sur., A-239. Dry. TD 3,899 ft.

W. A. Lofton and Thomas O. Peery 1 Campbell, Blk. 11, I. Holman Sur. Dry. TD 3,765 ft.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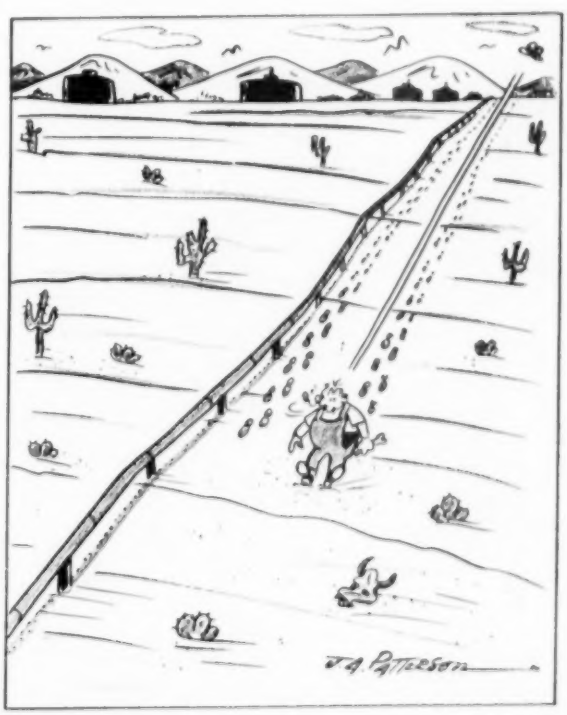

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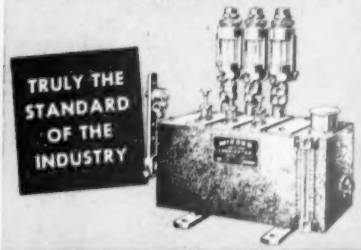


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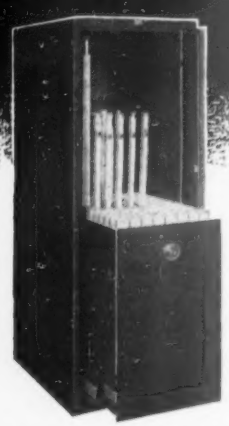

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## WILDCAT COMPLETIONS

Clay County: L. T. Burns 1 Hapgood, Blk. 10, Hopkins CSL. Dry. TD 6,350 ft.

R. W. Darden 1 Lyon, Blk. 50, 1 mile NE Petrolia. Dry. TD 1,860 ft.

O. P. Leonard 1 Mayfield, TE&L Sur. 3293, A-654. Dry. TD 6,050 ft.

Cooke County: Schonwald & Reynolds 1 Lewter, Lge. 76, Thomas Tinsley Sur., A-1453. Dry. TD 8,249 ft. Elev. 779 ft., Oil Creek sand 8,154-60 ft., Ellenburger 8,218 ft.

Cottle County: General Crude Oil Co. 1-B Swenson, 13-B-John H. Stephens Sur. Dry. TD 5,724 ft.

Denton County: Louis Fishman 1 Fred Cola, M. Langston Sur., A-739. Dry. TD 1,900 ft.

Jack County: Joe Blalock 1 Laird, John Walker Sur. Dry. TD 5,602 ft.

Bridwell Oil Co. 1 Maxey, J. Ariola Sur., A-3. Dry. TD 4,600 ft.

Arnold H. Bruner 1 Owen, A. Post Sur., A-1904. Dry. TD 4,528 ft.

R. B. Clark 1 Johnson, E. Smith Sur. Dry. TD 673 ft.

Montague County: Arnold H. Bruner 1 Melton, Abel A. Lewis Sur., A-420. Dry. TD 6,069 ft.

Hanlon-Boyle, Inc. 1 Thompson-McDonald, Blk. 57, Titus CSL. Dry. TD 6,208 ft.

Wilbarger County: A. W. Lofton 1-B Waggoner, 36-4-H&TC. Dry. TD 2,010 ft.

Presley Lomax 1-A Waggoner, 34-4-H&TC. Dry. TD 2,010 ft.

John & Pat O'Neil 1-EE Waggoner, 38-3-H&TC. Dry. TD 2,560 ft.

Young County: Brown Drilling Co. 1-A Stewart, TE&L Sur. 229. Dry. TD 1,030 ft.

Darden, Hannis & Richmond 1 Hayter, Blk. 2448, TE&L Sur. Dry. TD 1,246 ft.

W. B. Hamilton 6-A Morgan & Marshall, TE&L Sur. 3410, A-1230. Dry. TD 3,034 ft.

E. R. Perkins 5 Morrison, TE&L Sur. 159, A-406. Dry. TD 1,114 ft.

Wm. T. Roberts 1-F Jeffery, TE&L Sur. 3408, Fraction B. IP 384 BOPD, 10/64-in., 44°, Mississippian lime 4,714 ft. TD 4,729 ft.

Tennessee Production Co. 1-F Graham Stewart, Blk. 9, Young CSL., A-1284. Dry. TD 3,636 ft.

### WEST TEXAS

Borden County: British-American Oil Producing Co. 1 Beal, 4-30-T3N-T&P. Dry. TD 8,095 ft. Elev. 2,413 ft., Pennsylvanian 7,750 ft.

Brewster County: Slick-Urschel Oil Co. 1-47 Mary Decie, 47-4-GC&SF. Dry. TD 9,741 ft.

Coke County: Gore Drilling Co. 1 Conger, J. W. Johnson Sur. 1. Dry. TD 6,000 ft. Elev. 1,941 ft., Ellenburger 5,550 ft.

Crockett County: James H. Snowden 1 Martin, 14-OP-GC&SF. Dry. TD 1,018 ft.

Dawson County: Stanolind Oil & Gas Co. 1-A Graves, 48-34-T3N-T&P. IPP 13 BOPD, pay 9,281-87 ft. TD 9,348 ft.

Martin County: Western Drilling Co. 1 Glass, 9-39-T&P. Dry. TD 4,834 ft.

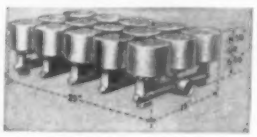
Presidio County: Wesley West 1 Bledsoe, 22-351-GC&SF, 3 miles NE Presidio. Dry. TD 12,499 ft.

Runnels County: Bert Fields 1 Smith, Sec. 15, T. M. Fowler Sur. IP 89 BO 7 hours, 16/64-in., 50°, lower Fry sand 4,330-44 ft. TD 4,885 ft.

Geochemical Surveys 2 Schwertner, Sec. 146, WCRR Sur. Dry. TD 4,400 ft.

Sutton County: Lowry Oil Co. 1 Allison, 16-A-9-Georgetown RR Sur. Dry. TD 6,673 ft. Elev. 2,370 ft., Ellenburger 6,577 ft.

NO FUEL WASTE



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## WILDCAT COMPLETIONS

Terry County: Anderson-Prichard Oil Corp. 1 Rich, 15-DD-J. H. Gibson Sur. Dry. TD 13,134 ft. Elev. 3,322 ft., Strawn 10,840 ft., Ellenburger 13,085 ft., pre-Cambrian 13,125 ft.

Tom Green County: The Gray-Wolfe Co. 1 Warlaw, Sec. 3, I&GN. Dry. TD 7,245 ft. Elev. 2,250 ft., Strawn 6,968 ft., Ellenburger 7,180 ft.

### SOUTHEAST NEW MEXICO

Lea County: Schermerhorn Oil Corp. 1 Gulf-State, 31-18s-37e. IP 674,000 cu. ft. gas, Queen sand 3,745 ft. TD 3,880 ft.

### NORTHERN NEW MEXICO

Sandoval County: Lowry et al 1 Renkoff "D," NE SW 17-19n-4w. Dry. TD 2,220 ft. OWDD.

San Juan County: F. W. Meyer 1 M.S.B., SE NW NE 13-23n-11w. Dry. TD 5,272 ft. in Dakota.

### ILLINOIS

Bond County: E. M. Self 1 Harneteaux, NW NW NW 22-4n-3w. Dry. TD 1,141 ft.

Christian County: Welker Oil Co. 1 Bramel, SW NW NE 31-16n-1w. Dry. TD 2,110 ft.

Clinton County: Dale Hopkins 1 Koelling, NW SE SW 21-1n-1w. Dry. TD 1,470 ft.

Superior Oil Co. 1 Seifert, NE SW SW 21-3n-2w. Dry. TD 3,713 ft.

Crawford County: S. J. Tucker 1 Colliflower Bros., NW NW NW 34-8n-11w. Dry. TD 1,411 ft.

Hamilton County: C. E. Brehm Drilling Co. 1 Douglas-Deen Community, NW NW SW 5-7s-6e. Dry. TD 3,390 ft.

C. E. Brehm 1 Hogan-Wooldridge, NW NE NE 12-7s-5e. Dry. TD 3,258 ft.

National Associated Petroleum Co. 1 Payne, SW NW NW 13-5s-7e. Dry. TD 3,484 ft.

Madison County: E. White 1 Zerges, NE NW NW 26-6n-7w. Dry. TD 565 ft.

White County: Marvin & Steber 1 Puckett, SE SE SE 8-5s-9e. Dry. TD 3,403 ft.

### INDIANA

Dubois County: H. C. Henderson 1 Arensman, NE NE NE 2-3s-5w. Dry. TD 811 ft.

H. C. Stone 1 Hoffman, NW NW SE 30-1n-4w. Dry. TD 646 ft.

Greene County: Frank Lyons 1 Markle, NW SW NW 31-8n-5w. Dry. TD 1,877 ft.

Posey County: G. C. Schoonmaker 1 Marx, SE SE SW 20-7s-12w. Dry. TD 2,705 ft.

Spencer County: W. S. Addington 1 Hagen, SW NW NW 24-6s-5w. Dry. TD 1,270 ft.

### WESTERN KENTUCKY

Daviess County: Stanoco Oil Co. 1 Riney, NW NW NW SE 12-O-27. Dry. TD 2,142 ft.

### MICHIGAN

Clinton County: Associated Drillers & Producers, Inc. 1 Wright, SW SE NE 2-8n-4w. Dry. TD 946 ft. in Stray-Marshall.

### OHIO

Coshocton County: B. G. Davis et al 1 E. & A. Swigert, Sec. 8, Jackson Township. Dry. TD 3,811 ft. in Clinton sand.

Portage County: Monarch Rubber Co. 1 Fee, Lot 30, Suffield Township. Dry. TD 4,540 ft. in Clinton sand.

### ALABAMA

Escambia County: Gulf Refining Co. 2 Atkinson, 17-1n-11e. Dry. TD 6,000 ft. Elev. 132 ft., Lower Cretaceous 5,908 ft.

Sunnyland Contracting Co. 1 Forte, C

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## WILDCAT COMPLETIONS

SW NE 10-1n-7e. Dry. TD 6,626 ft. Elev. 228 ft., Lower Cretaceous 6,398 ft.

Monroe County: Dawes et al 1 Braughton, C SW NE 11-6n-5e. Dry. TD 4,974 ft. Elev. 245 ft., Lower Cretaceous 4,827 ft.

### MISSISSIPPI

Adams County: H. L. Rowley 1 Bolden heirs, 12-7n-3w. Dry. TD 6,306 ft. Elev. 221 ft., Wilcox 4,103 ft., Baker shale 5,880 ft.

D. E. Vasser and R. H. Alagood 1 Stowers, 33-9-2w. Dry. TD 6,010 ft. Elev. 282 ft., Wilcox 3,876 ft., base Big shale 5,227 ft., Artman 5,593 ft.

George County: Crow Drilling Co. and S. P. Borden 1 Dantzler, C NE NE 11-2s-9w. Dry. TD 8,299 ft. Elev. 208 ft., lower Tuscaloosa 7,898 ft., Massive 8,200 ft.

### SOUTH LOUISIANA

Acadia Parish: Sun Oil Co. 1 Feitel-Kollitz, 5-10s-1w (Midland area). Dry. TD 13,250 ft.

Allen Parish: Sun Oil Co. 2 Chachere, 25-6s-5w. IP 190 BOPD, 8/64-in., 47.7°, perforations 8,062-66 ft. TD 8,200 ft. (New pay in Kinder field.)

Cameron Parish: British-American Oil Producing Co. 1-B Sweet Lake, 2-12s-7w. Dry. TD 13,838 ft.

Lafourche Parish: Paul F. Barnhart 1 Levert, 115-15s-16e. IP 2,000 M.c.f. daily (with distillate spray), 10/64-in., perforations 10,552-59 ft. TD 13,016 ft. (New field.)

Plaquemines Parish: Richardson & Bass 1 Stella, 16-14s-12e. Dry. TD 12,040 ft.

### NORTH LOUISIANA

Catahoula Parish: H. A. Harper et al 1 Tautom, C NW SE 10-8n-6e. Dry. TD 6,005 ft.

Concordia Parish: E. C. Wentworth, Como Drilling Co. and Acadian Petroleum Corp. 1 Murray, 11-7n-10e, 1 mile north Vidalia, 2¼ miles northeast Vidalia field. Dry. TD 6,225 ft.

### ARKANSAS

Hempstead County: H. J. Heartwell 1 Stroud, C SE SE 32-10s-25w. Dry. TD 2,400 ft.

Miller County: Don Fitzwater 1 Montana Realty Co., C NE SE 16-17s-28w. Dry. TD 5,720 ft.

### OKLAHOMA

Garvin County: Max Pray 1 Morris, C SE NW 20-4n-4w. Dry. TD 10,025 ft.

Hughes County: W. H. Strickler 1 Wallace estate, SE SE SW 14-8n-11e. Dry. TD 1,308 ft.

Jefferson County: Amerada Petroleum Corp. 1 Featherston, SE SW NW 35-3s-5w. Dry. TD 3,881 ft.

Kay County: Ayesh Oil Co.-D&L Oil Co. 1 Hammons, SE SE SW 9-26n-3e. Dry. TD 3,644 ft. Geological wildcat.

Lincoln County: Davidor & Davidor 1 Wakley, NE NE SE 21-15n-3e. IPF 198 BOPD, lower Skinner sand 4,294-4,304½ ft., 39°, 12/64-in. TD 4,314 ft. (Oil discovery.)

Davidor & Davidor 1 Anderson, NW NW SE 29-16n-4e. Dry. TD 4,391 ft.

D&L Oil Co. 1 Long, NW NW NW 4-16n-5e. Dry. TD 3,822 ft.

Oklahoma County: Ashland Oil & Refining Co. 1 Guthrey, SW SW NW 34-11n-1e. Dry. TD 6,431 ft.

Payne County: L. B. Jackson 1 Ritter, NW NW SW 22-20n-2e. Dry. TD 4,949 ft.

Pontotoc County: Wm. H. Pine 1 Little, SE NE SW 21-4n-4e. Dry. TD 1,441 ft.

Stephens County: Mack Oil Co. 1 Oxford, NW NW SW 26-1s-4w. IPP 30 BOPD, Pickens 4,110-44 ft., 17.5°. TD 7,521 ft. (Oil discovery.)

Texas County: The Texas Co. 1 Winfrey-Brown, NE NE SW 15-1n-19eCM. IP 12,100 M.c.f. of gas per day, Morrow sand 6,798-6,818 ft. TD 7,110 ft. (Gas discovery.)

### KANSAS

Barber County: Magnolia Petroleum Co. 1 Davis, SE SE SE 11-33s-11w. Dry. TD 5,100 ft.

Barton County: Coppinger 1 Bercher, SW SW SE 2-19s-13w. Dry. TD 3,455 ft.

Gove County: Virginia Drilling Co. 1 Neher, NW NW SW 27-11s-26w. Dry. TD 4,761 ft.

Graham County: Heathman & Seeglison 1 Sanger, NE NE NE 12-8s-25w. Dry. TD 4,400 ft.

Harper County: Cities Service Oil Co. 1 Hoopes, NW NE NE 35-33s-6w. Dry. TD 5,172 ft.

Kingman County: Pickrell 1 Boyle "B," NW NW NE 34-30s-8w. Dry. TD 4,397 ft.

Norton County: Empire Drilling Co. 1 Kohfeld, SE SE SW 21-2s-23w. Dry. TD 3,653 ft.

Pawnee County: Tex-Kan Oil Co. 1 Carr, SW NW NW 7-20s-19w. Dry. TD 4,310 ft.

Rooks County: Murfin Drilling Co. 1 Brown, NW NW SW 5-7s-18w. Dry. TD 3,510 ft.

Sedgwick County: J. P. Gaty 1 Heidrick, C E½ NE SW 29-29s-2e. Dry. TD 3,564 ft.

Seward County: Lanskan 1 Good "B," C NW NW 20-34s-31w. IP 1,700 M.c.f. of gas per day, Miss. 5,947-65 ft. TD 6,456 ft. (Opens Blue Bell Northwest pool.)

Columbian Fuel Corp. 1 Keating "B," C SE SE 13-34s-31w. Dry. TD 5,960 ft.

Stafford County: Trans Era 1 Moses-Aldrich, NW NW NE 19-22s-13w. Dry. TD 3,945 ft.

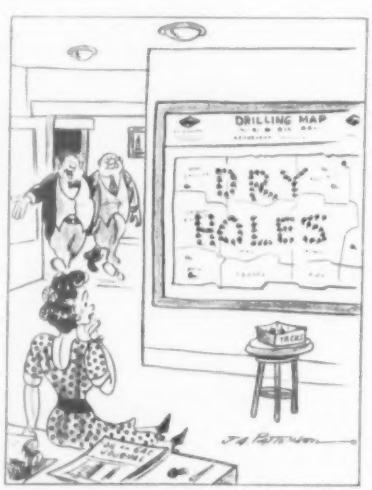
Sumner County: Champlin Refining Co. 1 Allen, SW NW NW 15-32s-2w. Dry. TD 4,430 ft.

Trego County: Branine-Roberts & Gould 1 Schemm, E½ SE NE 30-13s-22w. Dry. TD 4,515 ft.

Wabaunsee County: Musgrove et al 1 Palenske, SE SW SE 20-12s-10e. Dry. TD 3,280 ft.

### NEBRASKA

Cheyenne County: Gilliam Drilling Co. 1 Klentz, SW SW NE 29-13n-51w. Dry. TD 5,140 ft.




**"Well, how are things shaping up on the old drilling map this morning, Miss Smith?"**

Shell Oil Co. 1 Smith, SE NE NW 30-16n-52w. Dry. TD 5,616 ft.

Kimball County: Superior Oil Co. 73-6 Vrtatko, NW SE NE 6-13n-54w. Dry. TD 6,209 ft.

### SOUTH DAKOTA

Butte County: R. R. Harmon 1 Fishel, NW SW 19-8n-1e. Dry. TD 1,475 ft. in Minnelusa.

Fall River County: John R. Burrows 1 Government, C NW SE 1-10s-2e. Dry. TD 785 ft.

### NORTH DAKOTA

Bottineau County: J. P. Owen 1 Waters, C NE NW 22-161n-76w. Dry. TD 3,430 ft. in Lodgepole.

### CALIFORNIA

Colusa County: R. S. Rheem, Oper. 1-24 Zumwalt, 24-18n-2w. Dry. TD 4,025 ft.

Kern County: Superior Oil Co. 1 Sears, 21-25s-24e. Dry. TD 2,675 ft.

Los Angeles County: Tide Water Associated Oil Co. K-2 Sterling-McNally, 23-3s-11w. Dry. TD 6,594 ft.

Monterey County: General Petroleum Corp. 248-8 Hambey, 18-23s-11e. Dry. TD 3,051 ft.

Orange County: The Texas Co. 1 O'Neill estate, SE NE 22-8s-7w, IPP 19 BO in 48 hours, 45.8° gravity, perfs. 3,918-4,185 ft., TD 7,044 ft. PB 4,185 ft. (New field discovery near San Clemente, furtherest south oil production in state.)

Santa Barbara County: Union Oil Co. 1 Gila-Land, 35-5n-30w. Dry. TD 3,325 ft.

Tulare County: J. K. Wadley 1 Wadley, 17-22s-27e. Dry. Top granite 1,859 ft., TD 1,945 ft.

Ventura County: Standard Oil Co. of California 1 Sespe Ranch, SW SW 27-4n-20w, IPF 509 BOPD plus 1.1 per cent water cut, 21/64-in. choke, 27.2° gravity, 457 M.c.f. gas, perfs. 14,170-14,235 ft., TD 14,503 ft. (New Pliocene sand discovery, Spaulding zone of Fillmore field, 5 miles west of Fillmore.)

### MONTANA

Fallon County, Hay area: F. R. Anderson 1 Bohle, C NE NE 20-7n-57e. Dry. TD 9,512 ft. in Silurian.

### WYOMING

Niobrara County: Great Basin Petroleum Co. 1 Government 41-33, C NE NE 33-39n-65w. Dry. TD 7,638 ft. in Dakota.

Washakie County, Fourteen Mile Unit: Gulf Oil Corp. 1 Teeters, C SE NW 28-47n-93w. Dry. TD 12,206 ft. in Phosphoria.

Weston County: True & Brown-R. H. Fulton E-1 Western Empire-Government, C SW SE 2-42n-67w. IPF 800 BOPD. TD 7,590 ft. (Newcastle discovery.)

### COLORADO

Morgan County: Harper-Turner Oil Co. 1 Fries, C SE SW 20-3n-55w. Dry. TD 5,348 ft.

### LEGAL

U. S. DEPARTMENT OF THE INTERIOR, Bureau of Land Management, Washington 25, D.C. Notice is hereby given that SW¼-SW¼ sec. 22, T. 11 N., R. 20 W., S.B.M., California, containing 40 acres, within the known geologic structure of the Wheeler Ridge Field will be offered for oil and gas leasing through competitive bidding to the qualified bidder of the highest cash amount per acre at 1:00 p.m., E.S.T., May 12, 1954, when bids will be opened. Details of the lease offering, how and where to submit bids, and bid forms may be obtained upon request from the Manager of the Land Office, Los Angeles, California, or from the Bureau's Washington Office. L. E. Hoffman, Chief, Division of Minerals.

## WILDCAT COMPLETIONS

Petroleum, Inc. 1 Graham, C SW SW 15-2n-59w. Dry. TD 6,400 ft.

South Texas Development Co. 1 Government, C SW SW 14-2n-55w. Dry. TD 5,230 ft.

Sunbeam 1 State, NE NE SW 35-1n-58w. IPF 48 BOPH, ¾-in. TD 5,924 ft. ("J" sand discovery, new field.)

Washington County: S. D. Johnson and Lewis 1 Dimon, NE NE SE 14-5n-49w. Dry. TD 4,175 ft.

Weld County: S. D. Johnson 1 Lederhos, C SW SW 34-2n-62w. Dry. TD 7,147 ft.

**MANITOBA**

California Standard 5-21 Kirkella, LSD 5, 21-12-29w1. Dry. TD 2,790 ft.

**SASKATCHEWAN**

Imperial 11-28-37-25 Brun, LSD 11, 28-37-25w2. Dry. TD 1,557 ft.

Imperial 11-21-29-27 Marengo, LSD 11, 21-29-27w3. Dry. TD 2,316 ft.

**ALBERTA**

Great Plains-Canadian Superior et al 16-13 Elkton, LSD 16, 13-31-4w5. TD 8,894 ft. Mississippian gas well.

Imperial 12-16-40-22 Mirror, LSD 12, 16-40-22w4. D3 gas well. TD 5,652 ft.

Imperial 9-20-120-22 Russet Creek, LSD 9 20-120-22w5. Dry. TD 4,427 ft.

California Standard 9-26 Shekilie River, LSD 9, 26-120-11w6. Dry. TD 7,005 ft.

Amerada 11-26 Crown "AA," LSD 11, 26-69-23w5. D3 oil well. TD 8,785 ft.

Amerada 6-34 Crown "AC," LSD 6, 34-70-25w5. Dry. TD 5,354 ft.

# EQUIPMENT MEN

### Lightfoot Joins Lummus

The Lummus Co., New York, designing engineers and constructors for the petroleum and chemical industries, announces the association of C. E. (Todd) Lightfoot with the firm.

For the past 25 years, Lightfoot has been active in the chemical industry, in chemical economics, sales, marketing, and consulting.

### Rust to Manage Oilwell Wichita Falls Store

Appointment of E. E. Rust as manager of Oil Well Supply's store at Wichita Falls has been announced by V. J. Waters, manager of the Central Midwest area.

Rust went to his new post from Anson, Tex., where he had served as manager of Oilwell's branch store since 1948. He joined Oilwell in 1945 as an employe of the Anson store, where he was located until his promotion to manager.

### Manning, Maxwell & Moore To Start Canadian Plant

Manning, Maxwell & Moore of Canada, Ltd., has leased space from Canada Machinery Corp., Ltd. in Galt, Ont. According to officials of the parent company, Manning, Maxwell & Moore, Inc., Stratford, Conn., various types of industrial products are to be manufactured. These include Ashcroft pressure gages, Consolidated safety and safety relief valves, and Hancock bronze and steel valves in gate, globe, angle, Flo-control, and other types.

New officers, directors, and operating personnel include Hamilton Merrill, president; Chester H. Butterfield and Colby M. Chester III, vice presidents; Charles A. Moore III, treasurer; John A. Flynn, controller; Clark I. Scott, secretary; and Thomas F. Cummings, assistant secretary.

*(Continued on page 282)*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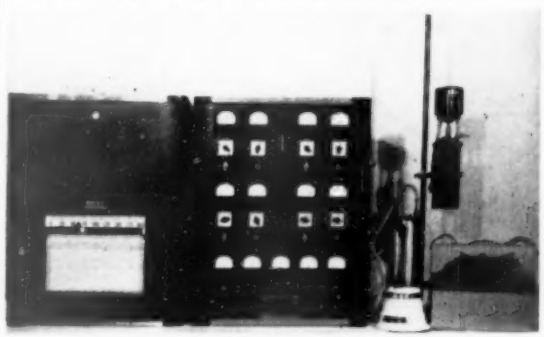

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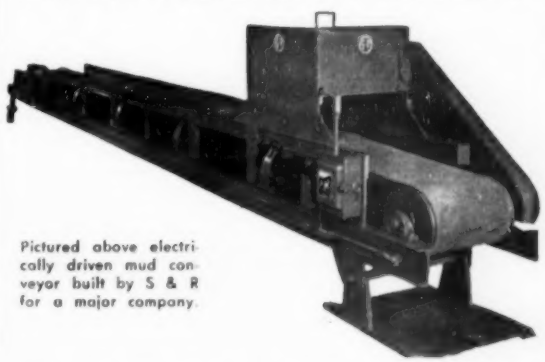

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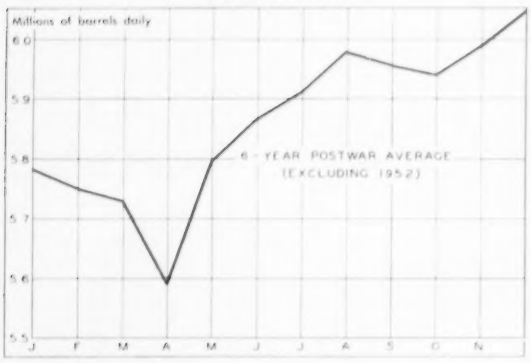
# Latest Figures . . . Industry Trends

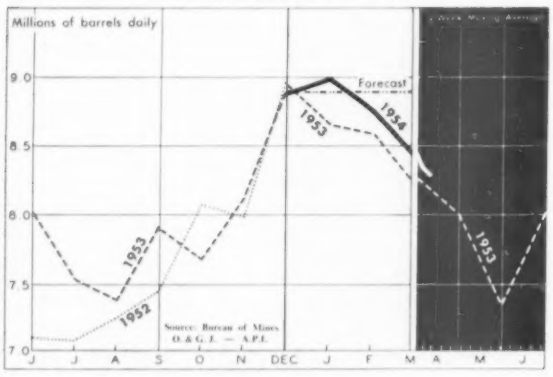
## A QUICK LOOK AT THE HIGHLIGHTS

| | LATEST WEEK | Change from WEEK AGO | | Change from YEAR AGO | |
|---|---|---|---|---|---|
| Production | 6,557,225 | UP | 75,825 | UP | 290,950 |
| Crude stocks | 268,547,000 | UP | 1,605,000 | DOWN | 7,437,000 |
| Completions | 1,048 | DOWN | 13 | UP | 143 |
| Refinery runs | 6,759,000 | DOWN | 2,000 | UP | 54,000 |
| Four-product stocks | 298,603,000 | DOWN | 1,787,000 | UP | 18,669,000 |
| Total imports | 1,050,600 | UP | 223,800 | UP | 141,900 |

REFINERY RUNS




TOTAL DEMAND—ALL OILS




# 8-Million-Barrel Crude-Stock Gain Seen in April

CURRENT trends in production and demand for crude oil indicate a decided increase in crude stocks for April which will be offset partially by a reduction in inventories of finished products.

Increases in production allowables in some of the important producing states have assured an increase in crude production this month of a little more than 100,000 bbl. daily.

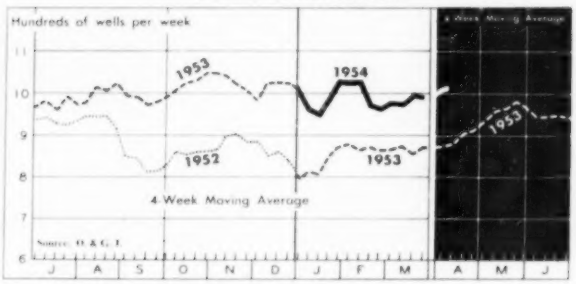
Total crude imports for April will be down only about 15,000 bbl. daily from March, based on statements to the Texas Railroad Commission by importing companies. If crude imports are held to these estimates, total new crude available in April will be up at least 85,000 bbl. daily or about 2,600,000 bbl. for the month. In other words, crude stocks in April will increase about 2,600,000 bbl. more than in March because of increased supply.

**Lower refinery runs . . .** April is normally the low month of the year for refining. The chart at left above shows the seasonal trend for refinery runs. The line represents daily average input by months for the period since the end of the war. For this chart, data for 1952 were omitted because of the distortion caused by the refinery strike.

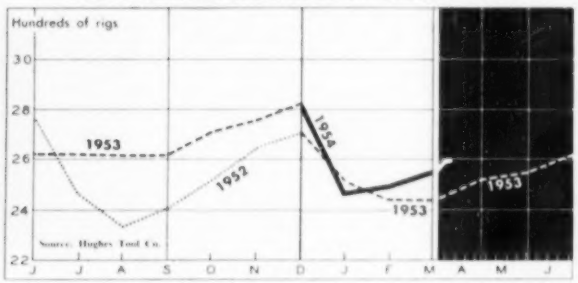
Note that the average runs for April dropped about 140,000 bbl. daily below the average for March. However, the drop this month may not be as severe as in the past since runs during the winter months were already below normal because of the effect of warm weather on heating-oil demand. Refinery runs may be down as much as 100,000 bbl. daily.

Increased production and reduced runs may result in a gain in crude stocks of as much as 8,000,000 bbl. this month.

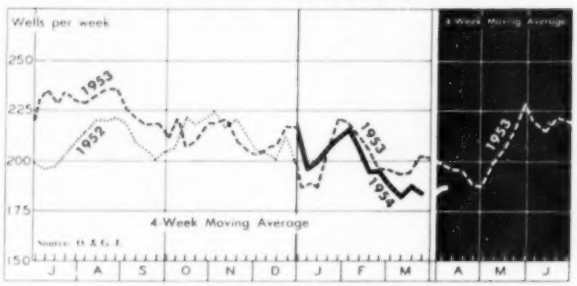
TOTAL COMPLETIONS




ROTARY RIGS OPERATING IN UNITED STATES




WILDCAT COMPLETIONS




ACTIVE ROTARY RIGS

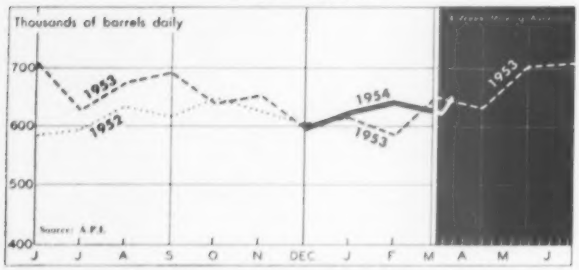
| Area— | 4-12-54 | Change from 4-5-54 | Change from 4-13-53 |
|---|---|---|---|
| Gulf Coast | 562 | 16 | —33 |
| N. and W. Texas-New Mexico | 804 | — 3 | —16 |
| Ark-N. La.-E. Texas | 192 | 12 | 66 |
| Oklahoma | 382 | — 2 | 58 |
| Kansas-S. Nebraska | 155 | —11 | —32 |
| Illinois-Eastern | 122 | —11 | 19 |
| Rocky Mountain | 240 | — 3 | 33 |
| Pacific Coast | 140 | 5 | —28 |
| Total United States | 2,597 | 3 | 67 |
| Western Canada | 152 | —10 | 6 |

## WEEKLY WELL COMPLETIONS . . . WEEK ENDED APRIL 10, 1954

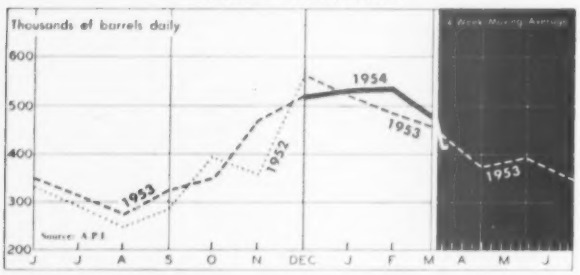
| | Total of all wells | | | | | Cum. | | Wildcat completions and discoveries | | | | | Cumulative total, 1954 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Comp. | Oil | Gas | Dry | Footage | 1954 | 1953 | Oil | Dist. | Gas | Dry | Total | Oil | Dist. | Gas | Dry | Total |
| Ala.-Ga.-Fla. | 3 | 0 | 0 | 3 | 17,600 | 35 | 36 | 0 | 0 | 0 | 3 | 3 | 1 | 0 | 1 | 29 | 31 |
| Arkansas | 16 | 9 | 0 | 7 | 48,409 | 200 | 137 | 0 | 0 | 0 | 2 | 2 | 8 | 0 | 0 | 28 | 36 |
| California | 46 | 38 | 0 | 8 | 220,015 | 677 | 685 | 2 | 0 | 0 | 6 | 8 | 25 | 0 | 5 | 142 | 172 |
| Colorado | 35 | 24 | 2 | 9 | 193,003 | 323 | 135 | 1 | 0 | 0 | 5 | 6 | 11 | 0 | 0 | 115 | 126 |
| Illinois | 67 | 32 | 0 | 35 | 160,300 | 710 | 458 | 1 | 0 | 0 | 10 | 11 | 2 | 0 | 0 | 120 | 122 |
| Indiana | 12 | 4 | 0 | 8 | 19,638 | 214 | 317 | 0 | 0 | 0 | 5 | 5 | 3 | 0 | 0 | 53 | 56 |
| Kansas | 99 | 44 | 8 | *47 | 328,290 | 1,233 | 1,313 | 0 | 0 | 1 | 15 | 16 | 19 | 0 | 5 | 155 | 179 |
| Kentucky | 18 | 6 | 5 | 7 | 39,481 | 294 | 274 | 0 | 0 | 0 | 1 | 1 | 6 | 0 | 0 | 31 | 37 |
| Louisiana | 66 | 43 | 3 | 20 | 348,762 | 935 | 697 | 1 | 0 | 1 | 5 | 7 | 29 | 17 | 8 | 78 | 132 |
| North | 43 | 34 | 0 | 9 | 117,721 | 492 | 309 | 0 | 0 | 0 | 2 | 2 | 4 | 0 | 1 | 27 | 32 |
| South | 23 | 9 | 3 | 11 | 231,041 | 443 | 388 | 1 | 0 | 1 | 3 | 5 | 25 | 17 | 7 | 51 | 100 |
| Michigan | 5 | 1 | 0 | 4 | 10,150 | 165 | 146 | 0 | 0 | 0 | 1 | 1 | 3 | 0 | 0 | 70 | 73 |
| Mississippi | 7 | 1 | 0 | 6 | 48,361 | 101 | 99 | 0 | 0 | 0 | 3 | 3 | 2 | 0 | 0 | 36 | 38 |
| Montana | 4 | 2 | 0 | 2 | 30,926 | 79 | 104 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 23 | 24 |
| Nebraska | 8 | 2 | 0 | 6 | 46,657 | 95 | 73 | 0 | 0 | 0 | 3 | 3 | 6 | 0 | 0 | 28 | 34 |
| New Mexico | 16 | 8 | 5 | 3 | 96,485 | 325 | 384 | 1 | 0 | 1 | 2 | 4 | 7 | 0 | 2 | 41 | 50 |
| North Dakota | 3 | 2 | 0 | 1 | 20,015 | 58 | 67 | 0 | 0 | 0 | 1 | 1 | 3 | 0 | 0 | 14 | 17 |
| Ohio | 21 | 11 | 3 | 7 | 50,754 | 297 | 275 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 2 | 3 | 5 |
| Oklahoma | 188 | 124 | 3 | ‡61 | 652,513 | 2,592 | 1,943 | 2 | 0 | 1 | 9 | 12 | 33 | 2 | 8 | 169 | 212 |
| Pennsylvania-New York | 50 | 24 | 3 | ‡23 | 79,200 | 672 | 634 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 2 | 10 | 12 |
| Texas | 348 | 204 | 10 | 134 | 1,569,733 | 4,929 | 4,597 | 12 | 4 | 1 | 87 | 104 | 199 | 26 | 43 | 1,098 | 1,366 |
| Southwest (1 & 4) | 47 | 33 | 0 | 14 | 210,613 | 708 | 738 | 4 | 3 | 0 | 10 | 17 | 19 | 15 | 13 | 190 | 237 |
| Gulf Coast (2 & 3) | 42 | 21 | 3 | 18 | 286,714 | 775 | 693 | 2 | 1 | 0 | 10 | 13 | 20 | 9 | 13 | 186 | 228 |
| East (5 & 6) | 26 | 8 | 4 | 14 | 132,673 | 242 | 224 | 0 | 0 | 1 | 6 | 7 | 5 | 0 | 4 | 64 | 73 |
| North Central (7-B & 9) | 146 | 77 | 0 | 69 | 480,981 | 1,838 | 1,674 | 4 | 0 | 0 | 48 | 52 | 96 | 2 | 5 | 440 | 543 |
| West (7-C & 8) | 68 | 52 | 1 | 15 | 393,203 | 1,130 | 1,033 | 2 | 0 | 0 | 10 | 12 | 59 | 0 | 6 | 199 | 264 |
| Panhandle (10) | 19 | 13 | 2 | 4 | 65,549 | 236 | 235 | 0 | 0 | 0 | 3 | 3 | 0 | 0 | 2 | 19 | 21 |
| Utah | 0 | 0 | 0 | 0 | 0 | 17 | 24 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 8 | 10 |
| West Virginia | 9 | 2 | 5 | 2 | 20,826 | 147 | 135 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 5 | 11 |
| Wyoming | 25 | 19 | 0 | 6 | 140,381 | 425 | 165 | 1 | 0 | 0 | 2 | 3 | 14 | 0 | 2 | 52 | 68 |
| Miscellaneous (S. D.) | 2 | 0 | 0 | 2 | 2,260 | 53 | 16 | 0 | 0 | 0 | 2 | 2 | 1 | 0 | 0 | 9 | 10 |
| Total United States | **1,048** | 600 | 47 | 401 | 4,143,759 | 14,576 | 12,714 | 21 | 4 | 5 | 167 | **197** | 375 | 45 | 84 | 2,317 | 2,821 |
| Total previous week | 1,061 | 643 | 54 | 364 | 4,299,022 | | | 29 | 4 | 4 | 150 | 187 | 354 | 41 | 79 | 2,150 | 2,624 |
| Total April 11, 1953 | 905 | 474 | 71 | 360 | 3,583,356 | | | 25 | 1 | 7 | 151 | 184 | 388 | 25 | 103 | 2,377 | 2,893 |

Service wells included: *1, †15, ‡19.

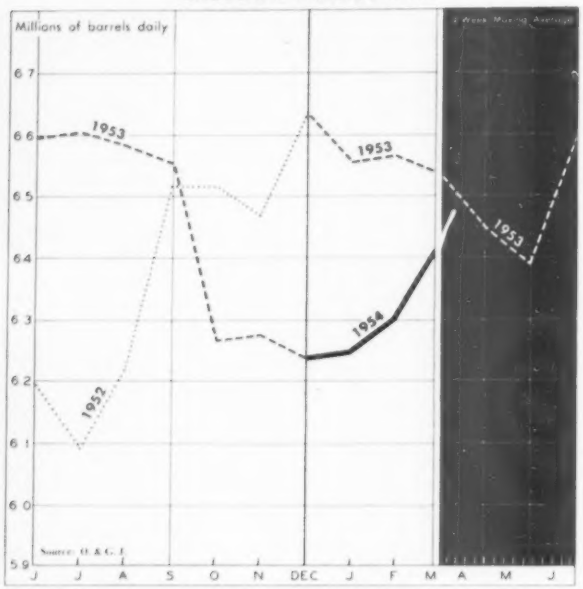
## CRUDE IMPORTS




## PRODUCT IMPORTS




## CRUDE-OIL PRODUCTION

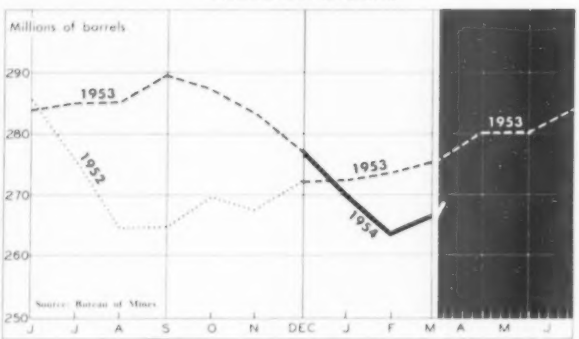



## DAILY AVERAGE PRODUCTION FOR WEEK

| | April 10 | | | April 3 |
|---|---|---|---|---|
| | Crude oil | Lease condensate | Total | total |
| Alabama | 4,200 | | 4,200 | 4,100 |
| Arkansas | 76,100 | 600 | 76,700 | 76,600 |
| California | 989,400 | | 989,400 | 991,800 |
| Colorado | 121,700 | | 121,700 | 119,900 |
| Eastern | 54,500 | | 54,500 | 54,500 |
| Florida | 1,525 | | 1,525 | 1,525 |
| Illinois | 176,700 | | 176,700 | 173,800 |
| Indiana | 31,900 | | 31,900 | 30,500 |
| Kansas | 331,900 | | 331,900 | 324,700 |
| Kentucky | 35,600 | | 35,600 | 35,600 |
| Louisiana | 675,950 | 47,300 | 723,250 | 702,600 |
| North | 105,950 | 3,800 | 109,750 | 109,100 |
| South | 570,000 | 43,500 | 613,500 | 593,500 |
| Michigan | 35,400 | | 35,400 | 36,800 |
| Mississippi | 88,300 | 3,700 | 92,000 | 92,750 |
| Montana | 30,100 | | 30,100 | 29,600 |
| Nebraska | 19,500 | | 19,500 | 19,400 |
| New Mexico | 206,700 | 1,700 | 208,400 | 207,875 |
| North Dakota | 14,500 | | 14,500 | 14,600 |
| Oklahoma | 519,800 | | 519,800 | 515,300 |
| Texas | 2,800,000 | 51,250 | 2,851,250 | 2,811,250 |
| Dist. 1 | 41,500 | 425 | 41,925 | 43,075 |
| Dist. 2 | 148,200 | 7,500 | 155,700 | 153,475 |
| Dist. 3 | 433,000 | 24,250 | 457,250 | 452,500 |
| Dist. 4 | 256,500 | 5,900 | 262,400 | 260,800 |
| Dist. 5 | 48,000 | 450 | 48,450 | 48,225 |
| Dist. 6 | 118,500 | 5,800 | 124,300 | 123,625 |
| East Texas field | 248,800 | | 248,800 | 244,900 |
| Dist. 7-B | 139,000 | 50 | 139,050 | 137,000 |
| Dist. 7-C | 184,000 | 4,750 | 188,750 | 184,000 |
| Dist. 8 | 902,000 | 1,500 | 903,500 | 884,475 |
| Dist. 9 | 194,000 | 600 | 194,600 | 193,450 |
| Dist. 10 | 86,500 | 25 | 86,525 | 85,725 |
| Utah | 4,800 | | 4,800 | 4,900 |
| Wyoming | 234,100 | | 234,100 | 233,300 |
| Total U. S. | 6,452,675 | 104,550 | **6,557,225** | 6,481,400 |
| Change from previous week, | | | **up 75,825** | |
| Canada | 175,125 | | 175,125 | 201,975 |
| Total U. S. production January 1-April 10 | | | 636,967,825 bbl. | |
| Same period last year (crude plus cond.) | | | *653,982,535 bbl. | |

*Includes 9,391,475 bbl. condensate.

## CRUDE-OIL STOCKS



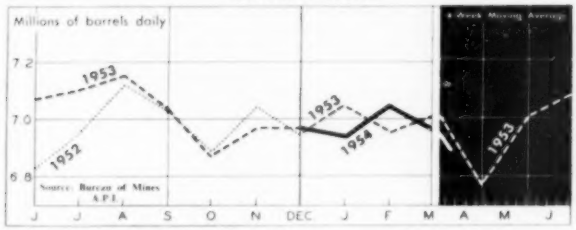

## CRUDE-OIL STOCKS BY STATES OF ORIGIN*

(Thousands of barrels)

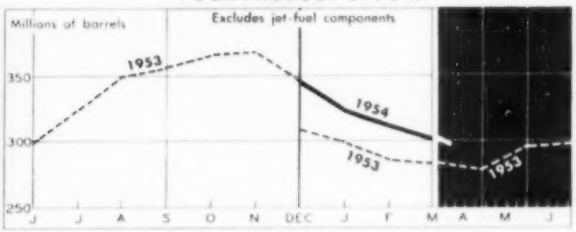
| | Apr. 3, '54 | Mar. 27, '54 | Apr. 4, '53 |
|---|---|---|---|
| Pennsylvania Grade | 2,791 | 2,770 | 2,472 |
| Other Appalachian | 1,791 | 1,658 | 1,610 |
| Illinois, Indiana, Michigan | 12,507 | 12,143 | 10,587 |
| Kansas | 9,537 | 10,154 | 10,312 |
| Oklahoma | 25,472 | 26,310 | 26,423 |
| Arkansas | 3,075 | 3,099 | 2,974 |
| Louisiana | 14,266 | 14,654 | 17,358 |
| North | 2,510 | 2,540 | 2,894 |
| Gulf | 11,756 | 12,114 | 14,464 |
| Mississippi | 3,315 | 3,336 | 3,915 |
| New Mexico | 7,467 | 7,517 | 7,067 |
| Texas | 125,073 | 121,842 | 134,988 |
| East Texas proper | 10,793 | 10,842 | 11,069 |
| West Texas | 54,092 | 51,466 | 63,711 |
| Texas Gulf | 26,014 | 26,027 | 26,202 |
| Other Texas | 34,173 | 33,507 | 34,006 |
| Wyoming | 13,808 | 13,800 | 14,031 |
| Other Rocky Mountain | 3,783 | 3,861 | 2,699 |
| California | 34,778 | 33,994 | 33,390 |
| Foreign | †10,885 | 11,804 | 8,158 |
| Total | 268,547 | 266,942 | 275,984 |

*Bureau of Mines. †Includes 2,560,000 bbl. in California.

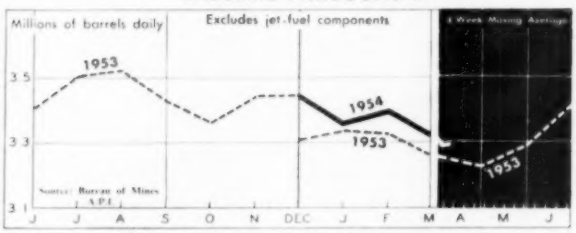
REFINERY RUNS



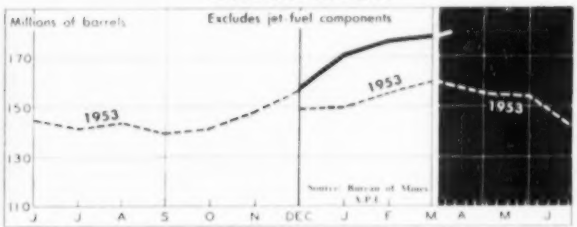

FOUR-PRODUCT STOCKS



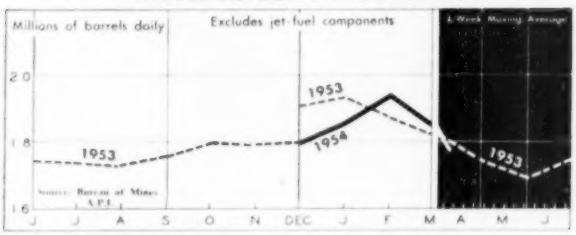

GASOLINE PRODUCTION



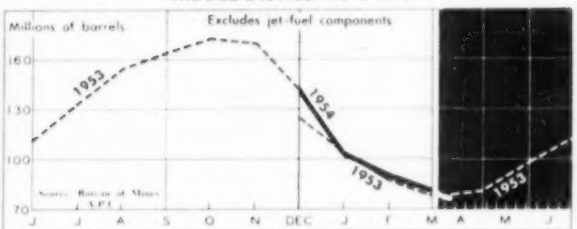

GASOLINE STOCKS



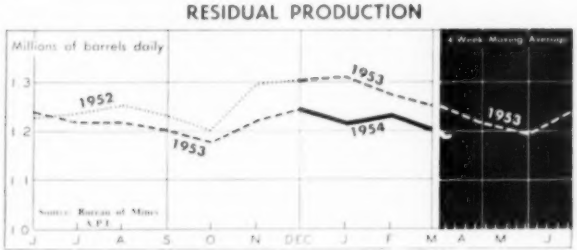

MIDDLE-DISTILLATE PRODUCTION



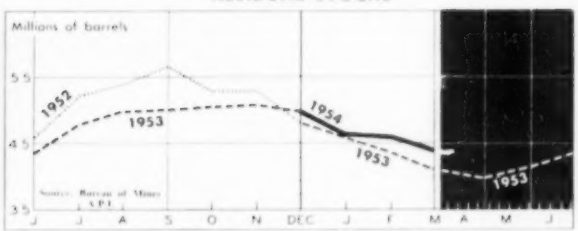

MIDDLE-DISTILLATE STOCKS




RESIDUAL PRODUCTION




RESIDUAL STOCKS




## A.P.I. REFINERY REPORT, APRIL 10

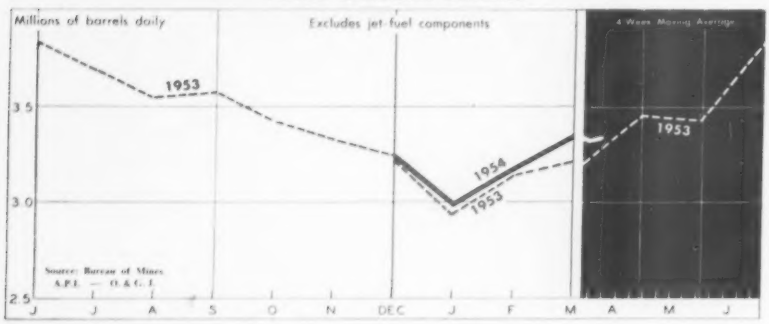
**(Excludes all jet-fuel components)**

(Thousands of barrels)

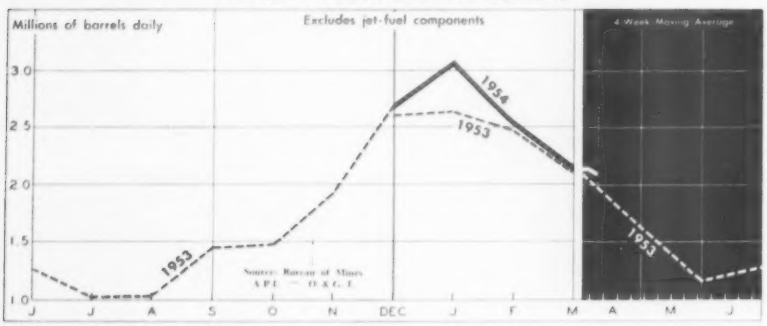
| District— | Daily avg. runs | Daily average production—Gaso.* | Kero. | Dist. | Resid. | Stocks‡—Gaso.† | Kero. | Dist. | Resid. | Bureau of Mines, April 1953: Daily avg. runs | Daily average production—Gaso.* | Kero. | Dist. | Resid. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| East Coast | 960 | 390.9 | 43.9 | 199.4 | 201.7 | 37,113 | 7,274 | 18,782 | 8,578 | 997 | 385.2 | 44.5 | 227.6 | 229.3 |
| Appalachian: | | | | | | | | | | | | | | |
| District 1 | 105 | 40.6 | 6.2 | 24.8 | 10.3 | 4,544 | 389 | 967 | 556 | 104 | 41.7 | 4.7 | 20.5 | 14.7 |
| District 2 | 51 | 36.3 | 0.8 | 12.0 | 9.2 | 2,431 | 264 | 368 | 399 | 80 | 44.0 | 4.8 | 14.3 | 13.9 |
| Ind., Ill., Ky. | 1,255 | 665.4 | 77.9 | 247.6 | 173.0 | 40,653 | 3,432 | 8,689 | 4,241 | 1,149 | 617.2 | 65.4 | 193.2 | 153.7 |
| Okla., Kans., Mo. | 566 | 347.8 | 19.7 | 122.3 | 43.9 | 20,111 | 970 | 6,184 | 1,245 | 556 | 310.6 | 17.8 | 121.2 | 54.5 |
| Inland Texas | 245 | 167.4 | 7.7 | 50.6 | 27.0 | 7,108 | 294 | 1,167 | 1,245 | 259 | 171.2 | 12.1 | 42.5 | 35.8 |
| Texas Gulf Coast | 1,708 | 778.3 | 110.4 | 364.6 | 247.9 | 23,044 | 2,201 | 5,747 | 4,531 | 1,726 | 793.0 | 131.3 | 409.6 | 248.2 |
| La. Gulf Coast | 555 | 260.6 | 55.7 | 123.0 | 58.4 | 9,358 | 1,508 | 2,815 | 1,059 | 553 | 267.6 | 41.0 | 149.2 | 55.5 |
| N. La. and Ark. | 93 | 37.3 | 9.0 | 24.0 | 6.1 | 4,096 | 390 | 1,092 | 109 | 86 | 34.1 | 8.5 | 20.6 | 7.1 |
| Rocky Mountain: | | | | | | | | | | | | | | |
| New Mexico | 19 | 10.7 | 0.3 | 2.8 | 2.7 | 190 | | 66 | 45 | 21 | 13.5 | 0.4 | 2.7 | 4.3 |
| Other Rocky Mtn. | 195 | 105.4 | 2.4 | 42.3 | 34.4 | 8,430 | 144 | 1,707 | 716 | 207 | 101.4 | 2.4 | 49.1 | 36.4 |
| California | 1,007 | 430.4 | 4.4 | 129.3 | 392.7 | 22,651 | 403 | 10,188 | 21,109 | 1,043 | 444.5 | 7.5 | 164.0 | 365.7 |
| Apr. 10, 1954 | 6,759 | 3,271.1 | 338.4 | 1,342.7 | 1,207.3 | 179,729 | 17,269 | 57,772 | 43,833 | 6,781 | 3,224.0 | 340.4 | 1,414.5 | 1,219.1 |
| Apr. 3, 1954 | 6,761 | 3,265.4 | 319.0 | 1,434.8 | 1,146.4 | 179,674 | 17,447 | 59,551 | 43,718 | | | | | |
| Apr. 11, 1953 | 6,705 | 3,156.9 | 363.6 | 1,388.9 | 1,246.1 | 159,893 | 18,685 | 60,693 | 40,663 | | | | | |

*At refineries including natural blended. †Finished and unfinished. ‡At refineries, bulk terminals, in transit, and in pipelines.

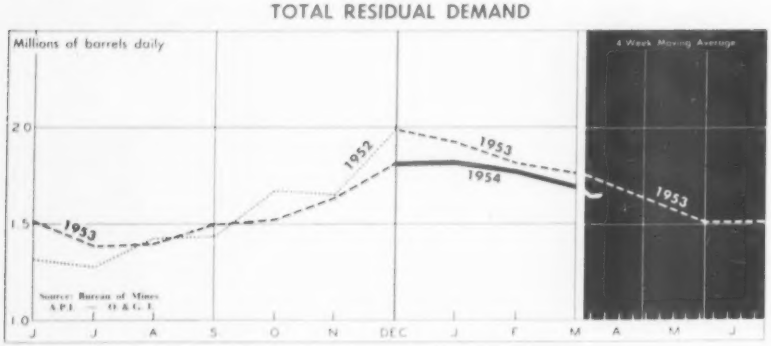
TOTAL GASOLINE DEMAND




TOTAL MIDDLE-DISTILLATE DEMAND




TOTAL RESIDUAL DEMAND




## REPRESENTATIVE QUOTATIONS

Spot-market quotations of leading suppliers as of April 14, 1954. Prices are in cents per gallon, except for residual in dollars per barrel and wax in cents per pound.

### GASOLINE, KEROSINE, AND FUEL OILS

| | Mid-Continent Group 3 | New York Harbor (barge) | Texas Gulf Coast |
|---|---|---|---|
| Regular gasoline | 10.75-11 | 11.5-12.25 | 10.25-10.5 |
| Premium gasoline | 11.75-12 | 13.25-14 | 11.5-12.25 |
| 42-44 w.w. kerosine | 9.125-9.375 | 10.2-10.4 | 9.25-9.5 |
| No. 2 straw fuel oil | 8.25-8.375 | 9.2-9.4 | 8.25-8.5 |
| No. 6 residual | $1.20-1.30 | $2.20-2.40 | $1.85-1.95 |

### NATURAL GASOLINE

| | Group 3 | North Texas | N. La. |
|---|---|---|---|
| Grade 26-70 | 4.0 | 3.5 | 3.75 |
| Grade 18-55 | 4.8 | 4.3 | 4.55 |

### LUBRICATING OILS
**Mid-Continent**

| | |
|---|---|
| 150-160 vis., D bright stock, 0-10 pp. | 18 |
| 200 vis., No. 3 neutral, 0-10 pp. | 13.25 |

### WAX
**Mid-Continent**

| | |
|---|---|
| 132-134 A.M.P. | 6.0 |

● Important price changes of the week were confined to lower postings for tank-wagon delivery of light heating oils in upper New York and in parts of New England. Distillate and kerosine are more readily available on the Gulf Coast.

### PRODUCTION AND DEMAND—MAJOR PRODUCTS

(Thousands of barrels daily)

| | Refinery prod. | Total demand |
|---|---|---|
| Gasoline: | | |
| Four weeks ended 4-10-54 | 3,298 | 3,326 |
| January 1954 | 3,354 | 2,985 |
| July 1953 | 3,501 | 3,690 |
| April 1953 | 3,224 | 3,473 |
| Middle distillate: | | |
| Four weeks ended 4-10-54 | 1,768 | 2,085 |
| January 1954 | 1,857 | 3,075 |
| July 1953 | 1,735 | 1,035 |
| April 1953 | 1,755 | 1,647 |
| Residual fuel: | | |
| Four weeks ended 4-10-54 | 1,187 | 1,653 |
| January 1954 | 1,271 | 1,835 |
| July 1953 | 1,224 | 1,390 |
| April 1953 | 1,219 | 1,652 |

## CRUDE PRICES
### GRAVITY SCHEDULE

| | Signal Hill, Calif.* | Okla-homa, Kansas | Gulf Coast Tex.† | West Tex.‡ |
|---|---|---|---|---|
| 14-14.9 | $1.87 | | | |
| 15-15.9 | 1.93 | | | |
| 16-16.9 | 1.99 | | | |
| 17-17.9 | 2.05 | | | |
| 18-18.9 | 2.11 | | | |
| 19-19.9 | 2.18 | | | |
| 20-20.9 | 2.24 | $2.50 | | $2.37 |
| 21-21.9 | 2.30 | 2.52 | | 2.39 |
| 22-22.9 | 2.37 | 2.54 | | 2.41 |
| 23-23.9 | 2.45 | 2.56 | | 2.43 |
| 24-24.9 | 2.53 | 2.58 | $2.91 | 2.45 |
| 25-25.9 | 2.61 | 2.60 | 2.93 | 2.47 |
| 26-26.9 | 2.69 | 2.62 | 2.95 | 2.49 |
| 27-27.9 | 2.76 | 2.64 | 2.97 | 2.51 |
| 28-28.9 | 2.83 | 2.66 | 2.99 | 2.53 |
| 29-29.9 | 2.91 | 2.68 | 3.01 | 2.55 |
| 30-30.9 | 2.97 | 2.70 | 3.03 | 2.57 |
| 31-31.9 | 3.04 | 2.72 | 3.05 | 2.59 |
| 32-32.9 | 3.12 | 2.74 | 3.07 | 2.61 |
| 33-33.9 | | 2.76 | 3.09 | 2.63 |
| 34-34.9 | | 2.78 | 3.11 | 2.65 |
| 35-35.9 | | 2.80 | 3.13 | 2.67 |
| 36-36.9 | | 2.82 | 3.15 | 2.69 |
| 37-37.9 | | 2.84 | 3.17 | 2.71 |
| 38-38.9 | | 2.86 | 3.19 | 2.73 |
| 39-39.9 | | 2.88 | 3.21 | 2.75 |
| 40 and above | | 2.90 | 3.23 | 2.77 |

*Standard Oil Co. of California. †Upper Texas Gulf Coast. ‡Includes New Mexico Permian.

Prices east of California effective June 15, 1953. California prices effective February 16, 1953. Pennsylvania Grade prices effective January 1, 1954.

## FLAT CRUDE PRICES

Representative posted schedules per barrel.

| | |
|---|---|
| Louisiana: | |
| Cotton Valley (distillate) | $3.00 |
| Cotton Valley (Holloway crude) | 2.95 |
| Texas: | |
| East Texas | 2.90 |
| Chapel Hill | 2.83 |
| Conroe | 3.13 |
| Van | 2.73 |
| Pennsylvania Grade: | |
| Bradford | 3.76 |
| Middle District | 3.70 |
| Southwest Pennsylvania | 3.31 |
| West Virginia | 3.25 |
| Ohio | 3.24 |
| Illinois Basin | 3.02 |

## *"... More than 50% of our employees are on the Payroll Savings Plan ..."*

**PAUL W. JOHNSTON**
President, Erie Railroad

***"We on the Erie Railroad are extremely proud that 50% of our employees are on the Payroll Savings Plan for U.S. Defense Bonds. These thousands of employees are regularly providing for their own future security and at the same time contributing to the strength of our national defense. The American habit of thrift and regular purchase of U.S. Defense Bonds Shares in America are evidences of good, sound citizenship."***

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For the same four reasons, more than 7,500,000 employed men and women in thousands of other companies are active members of the Payroll Savings Plan —their take-home savings in the form of U.S. Defense Bonds total more than $150,000,000 per month.

Is your company in the "more than 50% participation" group? If it isn't, please bring this page to the attention of your top executive. Point out to him—

**Two Simple Steps to a Successful Payroll Savings Plan**

1. Phone, wire or write to Savings Bond Division, U.S. Treasury Department, Suite 700, Washington Building, Washington, D. C.
2. Your State Director, Savings Bond Division, will show your company how to conduct a simple person-to-person canvass that will put a Payroll Savings Application Blank in the hands of *every* employee.

That is all management has to do. Your employees will do the rest. They, like the employees of the Erie Railroad, want to provide for their personal security and at the same time do their part in helping to keep America strong.

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**TULSA 1, OKLAHOMA**

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83 STAR SPUDDER with tools from 13" down to 5". Winch truck and all small tools. Reason for selling: illness. H. C. Full, RR #1, Box 249, Terre Haute, Indiana. Phone: CRawford 63013.

SEVERAL FAILING MODEL 1500 rigs, various ages, conditions and inventories. P. O. Box 643, Billings, Montana.

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5—Cooper Type 80 Twin. Comp. Cyl. to suit.
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1—Bessemer Type X Single.
Compressor Cylinders, Coopers, Clarks, and Bessemer various sizes and W.P. 2" stroke
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FOR SALE: 1—36L Bucyrus Rig, 1—C-37 Walker-Neer Rig, 1—RL3 Drum Cardwell Rig—all three complete with tools. Light plant, tool house and all accessories. Can be seen working now in West Texas. Contact by phone 2-4743 or write P. O. Box 2608, Midland, Texas.

1—Used Superior 90 H.P. Twin Duplex 2 Stage Gas Engine Compressor complete with Sturdevant Cooling System and Cooper-Bessemer Starting Compressor. Box H-149, The Oil and Gas Journal, Tulsa, Oklahoma.

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**DIESEL POWER UNITS**

| | |
|---|---|
| WAKD Waukesha—Late Model | $2000.00 |
| 148-DK Waukesha | 1500.00 |
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| | |
|---|---|
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| GAK145—runs good | 1000.00 |
| GK145—runs good | 1200.00 |
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New lubricated plug cocks at interesting prices.

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|---|---|---|
| (13)—1½" | Nordco series 1500 | #3044 |
| (24)—2½" | " " " " | 1500 #3044 |
| (7)—1" | " " " " | 1500 #3044 |
| (8)—1½" | " " " " | 1500 #3044 |
| (7)—4" | " " " " | 150 #1945-RJ |
| (2)—4" | " " " " | 400 #2145-RJ |
| (2)—4" | " " " " | 600 #2249-RF |
| (2)—4" | " " " " | 900 #2345ME3-RF |
| (1)—8" | " " " " | 300 #4285-RF |
| (3)—8" | " " " " | 150 #1985RF |
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FAILING model heavy duty 1500 drill and water truck. Write to Box 819, Longmont, Colorado, for details.

MODEL H CARDWELL Servicing Unit. Truck mounted with mast. Fully equipped. Box No. 1 or Phone 153, Canton, Kansas.

FOR SALE: 5½" x 20" Class 'Y' Cooper Compressor Cylinders, 90 hp. Superior Compressor skid mounted, 4"—500 lbs. gate valves, electric driven centrifugal water pumps. Alfred B. Kern, 227 Wright Building, Tulsa 3, Oklahoma.

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**Attn.: W. H. ORR**
**Phones: 132—Rockdale, Texas**
**AT-3427—Houston, Texas**

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| 16" O.D. | .375 wall | 1,460 feet |
| 20" O.D. | .281 wall | 1,300 feet |
| 24" O.D. | .281 wall | 720 feet |
| 24" O.D. | .406 wall | 920 feet |
| 26" O.D. | .281 wall | 1,100 feet |
| 26" O.D. | .312 wall | 820 feet |
| 26" O.D. | .500 wall | 120 feet |

All 40 foot lengths
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WANTED: Complete Rotary Rig, U 15 or National 50 Class, preferably located in West Texas. Box H-106, The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED IMMEDIATELY: Ductility machine, penetrometer, and other asphalt lab equipment. Box H-122, The Oil and Gas Journal, Tulsa, Oklahoma.

**250,000 FT. 8⅝ o.d. pipe with collar and plain end. $1.00 per foot Oklahoma. Rogers & Lundquist, 620 Wright Building, Tulsa, Okla. Phone 3-2072—5-8850**

## HELP WANTED

FOREIGN EMPLOYMENT. List of oil companies and drilling contractors showing where to apply for foreign jobs. OIML Co., Box 2603, Tulsa, Okla. $5.00 cash.

Experienced products pipeline superintendent with minimum of five years experience on products pipelines. Must be qualified to take complete charge of new 12,000 BPD products line. Give complete data and salary expected. Replies strictly confidential. Box H-150, The Oil and Gas Journal, Tulsa, Oklahoma.

ENGINEERS, Executives, Technical Men Salaried positions—$3600 to $30,000. This confidential service for outstanding men who desire a change of connection. Will develop and conduct preliminary negotiations without risk to present position. Send name and address for details. Tomsett Associates, 434 Frick Bldg., Pittsburgh 19, Pa.

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With minimum 3 years' experience in development, production and oil and gas reservoir engineering on primary and secondary recovery problems. For New York office of major foreign producer. Write giving full particulars regarding personal history and work experience. Please include telephone number.

### RECRUITING SUPERVISOR BOX OGJ-7

Arabian American Oil Company

**505 Park Avenue**
**New York 22, N. Y.**

## HELP WANTED

### PETROLEUM OR RESERVOIR ENGINEER

For New York office of major foreign producer. Proficient in mathematics with 4 or more years' extensive experience in oil and gas reservoir engineering on primary and secondary recovery problems. Duties will include preparations of basic field production and reservoir data for application in analogue and digital computors, performance of analytical analysis of field behavior and interpretation and preparation of resulting data for reservoir engineering reports on specific fields.

Write giving full particulars regarding personal history and work experience. Please include telephone number.

### RECRUITING SUPERVISOR BOX OG-1

Arabian American Oil Company

**505 Park Avenue**
**New York 22, N. Y.**

WANTED: Manufacturer's representative now calling on supply stores to represent old established manufacturer of sub surface pumping and production equipment. Several open territories. Box H-144, The Oil and Gas Journal, Tulsa, Oklahoma.

ENGINEER with structural experience and some knowledge of drilling equipment or methods desired by recognized oil field equipment company for contact work and sale of derricks and all related drilling structures. Box G-990, The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED: Manufacturers representatives with good following calling on Oil Producers and Supply Stores to represent Manufacturer of the Hunter Flex-Seal oil well pump plunger and packing means for same. Wants Commission Sales Representatives for following territories: Kansas, Arkansas and North Louisiana, East Texas, West Texas, and California. Please give details concerning present Sales Coverage first letter. All replies confidential. W. H. Hunter Engineering Company, 150 Marlborough Dr., Pontiac 19, Michigan.

OIL INDUSTRY Employment Service. Tom Robinson, owner, 405 Tuloma Bldg. Tulsa, Oklahoma. For technical and trained oil industry personnel. Write for blank.

PHOTOGEOLOGIST—To head photogeolic interpretation section. Must be College graduate—5 years experience—mining experience desirable. Write giving age, education and full details of experience. All replies confidential. Box G-968, The Oil and Gas Journal, Tulsa, Oklahoma.

SOUTH AMERICA. Major Oil Company. Our fee paid. Petroleum Engineer—Drilling Engineer—Electrical Engineer—All requiring degree, some experience, under 40. Toolpusher—3 or more years experience, under 40. General Clerk—2 or more years experience in production department, knowledge stenography desirable, under 32. All information confidential. Contact Chas. J. Loveless Personnel Service, 616 S. Main, Tulsa, Oklahoma. Phone 3-5168.

**SUPERVISOR OF CATALYTIC CRACKING AND ALLIED OPERATIONS**

Modern Mid-Continent refinery seeks man to supervise fluid catalytic cracking and allied operations. Must have fluid cracking and general refinery experience. College degree or equivalent. In reply please state qualifications. All replies confidential. Our employees know of this ad.

**Box H-154, The Oil and Gas Journal, Tulsa, Oklahoma**

## SITUATIONS WANTED

SECONDARY RECOVERY: Penn State Petroleum Engineering graduate; 21 years thorough experience, all phases field and engineering work. Thos. O. Glenn, 221 North Perry St., Titusville, Pa.

GEOLOGIST - GEOPHYSICIST. Fourteen years experience. Seven years seismic supervisor Gulf Coast, Rocky Mountain Division and Canada. Desires position as coordinator, geologist-geophysicist, or manager uranium exploration with oil or mining company. Now residing Denver. Prefer Rocky Mountain Area. Box H-143, The Oil and Gas Journal, Tulsa, Oklahoma.

LANDMAN-LAWYER desires to relocate in Rocky Mountain Area. Presently with major oil company. Member state bar. Young. Married. Box H-140, The Oil and Gas Journal, Tulsa, Oklahoma.

GEOPHYSICIST: Nine years seismograph experience Latin America—States; Age 38. Consider Foreign. Box H-139, The Oil and Gas Journal, Tulsa, Oklahoma.

EXPERIENCED GEOLOGIST 15 YEARS. Five years and 10 field seasons Rocky Mountains. Background: University professor; major oil company research; well site, surface, subsurface, reservoir, administration and public relations. Formerly division geologist for independent. Age 37. Salary or retainer. Write: Turner, 2121 So. Holly, Denver.

ENGINEER: B.S. and M.S. degrees. 6 years varied experience in petroleum development, production and reservoir engineering. Desires position in Texas-Louisiana area. Will consider other areas, including foreign. Box H-136, The Oil and Gas Journal, Tulsa, Oklahoma.

PETROLEUM GEOLOGIST, Master's degree, Age 27, single. Over two years experience, mostly on subsurface and regional studies. Will consider any locality. Box H-155, The Oil and Gas Journal, Tulsa, Oklahoma.

SALES MANAGEMENT POSITION. Presently district manager national concern supervising eight-state area. Formerly sales manager industrial supply house specializing in air, oil, water, gas, steam, and hydraulic equipment. Four years oil-field experience. Thoroughly familiar Mid-Continent and Southern California areas. Present income $10,000 per year. Willing to relocate. Box H-156, The Oil and Gas Journal, Tulsa, Oklahoma.

GEOLOGIST: 35, married, Master's degree, present managerial position; experienced oil and uranium exploration, leasing, engineering, deals and farmouts. Desires position with aggressive independent or individuals in Rocky Mountain region. Box H-148, The Oil and Gas Journal, Tulsa, Oklahoma.

PETROLEUM GEOLOGIST, Age 25, West Texas and Gulf Coast experience. 4 years experience in structural geology, logging, regional studies, desires responsible position with independent in Upper Gulf Coast area. Box H-152, The Oil and Gas Journal, Tulsa, Oklahoma.

OILFIELD SUPPLY Salesman 8 yrs. experience, age 35, married, now employed, desires managership of new supply co., specialty and mfgrs. deals considered. Box H-151, The Oil and Gas Journal, Tulsa, Oklahoma.

OIL COMPANY EXECUTIVE—Attorney under 45. Experienced in legal, leases, royalty, personnel, exploration, development, production, rotary contract drilling, and financing. 10 years manager and top executive positions in the oil industry. Presently employed. Box H-147, The Oil and Gas Journal, Tulsa, Oklahoma.

ATTENTION: Well established oil well drilling contractor desires to manage and supervise: Individuals', groups', small or medium-sized oil companies' drilling, production and operating problems in Central and Western Texas and New Mexico. Personal interview by appointment is desired. Makin Drilling Company, Box No. 1678, Ph. No. 3-3141, Hobbs, New Mexico.

PETROLEUM ENGINEER, Age 32, competent, aggressive; experienced in production, drilling, reservoir analysis, proration. Desires responsible position in Rocky Mountain Area. Box H-131, The Oil and Gas Journal, Tulsa, Oklahoma.

LEASE AND DRILLING BLOCKS

LEASE AND DRILLING BLOCKS

## WANT TO DRILL A SALT DOME WELL ON GRADE A SHOT PICTURE?

Have 1,000 acres commercial leases, southwest flank Sikes salt dome, Winn Parish, Louisiana. Want to drill well to test first five sands, Wilcox formation (Eocene).

Offer one-half interest in all the 1,000 acres and completed well down to and including the coring of the sand for $20,000.00.

Will secure with diamonds at appraised value. If not a big producer, you keep the diamonds. Contact **L. C. STEVENS, Winnfield Hotel, Winnfield, Louisiana.**

LEASES FOR SALE or DEAL—240 acres section 30-1-26, Decatur County, Kansas. 640 acres section 31-22-18, Pawnee County, Kansas. S½ of Section 11-2-27, Decatur County, Kansas. Box 527, Chappell, Neb.

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FOR SALE: 763 acre one fee owner oil lease near Center, Shelby County, Texas. In the play joins Humble, Gulf, Sun acreage, four dollars per acre, several smaller tracts same area five dollars acre. We only solicit buyers who know the oil business. W. H. Liem, Box 287, Center, Texas.

WILL pay cash instantly for lease (large blocks), royalties, mineral deeds, production. Write fully—P. O. Box 2153, Denver, Colorado.

TWENTY-FIVE THOUSAND FIVE HUNDRED ACRES drilling block, located on excellent gravity meter surveyed high South Georgia. Can furnish copy of survey. No well ever drilled on structure. Oil and gas seepages. Tuscaloosa and Eutaw formations exist in this section of Georgia. Will sell entire block account of illness, fifty cents per acre. No rental due for two years, ⅛ royalty landowner, ten year leases, 10c per acre. Good prospect for test well. Geology available to interested parties. T. R. Davis, 406 E. 6th Street, Vidalia, Georgia, Phone 3639.

⅛ MINERALS or royalty desired on a section in the active eastern Wyoming area. State township, cost, lessee and drilling commitment. Box H-153, The Oil and Gas Journal, Tulsa, Oklahoma.

MAKE ME A DEAL TO DRILL. 100 acres John Taylor Survey, Cherokee County, Texas. August J. Randa, 933 Caulder, Des Moines, Iowa. Phone 3-6193.

LEASES, DRILLING BLOCKS, all Southwestern States areas, bought and sold. Burkett, 3455 Johnette St., Shreveport, La.

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**INDICATED FIELD SE NEW MEX.**

Well to drill next to S.I. well which showed for prod. 2 zones Permian. Some 1/100th interests in well & blk. at attractive price. Data on request.

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**1919-1954**
**Portales** **New Mexico**

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**Bought and Sold—Any Area**
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**B. D. BUCKLEY**
**6635 Delmar Ave., St. Louis 5, Mo**

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**WANTED**

WANTED: STRIPPER PRODUCTION, Bartlesville sand, for water flood. Southeastern Kansas. Please give full information. Box G-996, The Oil and Gas Journal, Tulsa, Oklahoma.

**RANCHES**

SALE OR FARMOUT—All or part 18,000 acres Fremont Co., Wyo. Production three sides. 1068 acres Weston Co., Wyo. Close to production. L. K. Strauss, Temple, R. D. 1, Pa. Phone Reading 9-4673.

**550 MEADOWLAND ACRES, HEART OF COLORADO ROCKIES**

Fisherman's or Hunter's paradise! 550 acres rolling and meadowland in heart of Colorado Rockies, amidst scenic grandeur. Summers 500 cattle. 6 lakes; 2 miles of stream, all abundantly stocked with trout. 5 cabins (2 doubles), (3 have running water, toilets, showers). Summers 100 cattle. At present 2 meadows in lush hay; more could be cultivated easily. Cabins bring $70 and more a day, $35,000. We have other vast and medium size sheep and cattle ranches.

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**BUSINESS OPPORTUNITIES**

CAPITAL WANTED, $50,000 to form drilling company. Contacts assured. Kansas-Oklahoma area. Will work for wages till assets double then ¼, will take complete charge. Box H-146, The Oil and Gas Journal, Tulsa, Oklahoma.

PARTNER WANTED: In developing an oil field along Ohio Valley and another in Mississippi. References exchanged. Details after personal contact. W. R. Bedingfield, 822 Southern Finance Bldg., Augusta, Georgia.

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**P. O. Box 373** — **Shreveport, La.**


# EQUIPMENT MEN

## . . . in the News

*(Continued from page 273)*

### Totco Designates Oklahoma, Kansas as a Division

R. W. ARD

J. R. ACTON

The Technical Oil Tool Corp. service organization in Oklahoma and Kansas has been designated a division and placed under the direction of R. W. (Bo) Ard, who has been named division manager. Ard, with Totco since 1949, will operate from headquarters in Oklahoma City.

To increase the effectiveness of Totco service near Oklahoma City, James R. Acton was added to the Totco staff.

### Marley Builds Plant for Packaged Cooling Towers

The Marley Co., Kansas City, Mo., has built a new plant in Louisville, Ky., to meet the demand for the company's Aquatowers, mechanical draft cooling towers.

Occupying 10 acres, the new plant provides 77,000 sq. ft. of production space, and is equipped with modern machinery for rapid fabrication of packaged water cooling towers. Here steel Aquatowers will be manufactured in a complete range of standard sizes. In addition, new all steel counterflow

towers will be fabricated for large capacity water cooling service. Another product of this facility is the company's line of DriCooler air-cooled heat exchangers.

The new plant supplements Marley's other manufacturing facilities in Kansas City, Kans.; Stockton, Calif., and Houston.

## Pluta Joins Staff of Century Geophysical

J. S. PLUTA

Joseph S. Pluta, formerly of Houston has joined the supervisory staff of Century Geophysical Corp., according to Ben F. Rummerfield, vice president of the company.

Pluta attended McGill University, Montreal, Que., and DalHousie University, Halifax, N. S., where he earned a M.S. degree in geology. He has had 7 years' seismic experience in Canada and the United States, and has spent 6 years of this time in the West Texas, New Mexico, and Oklahoma areas. He was formerly senior geophysicist-geologist for Standard Oil Co. of Texas in the company's Midland division office.

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### LEGAL

U. S. DEPARTMENT OF THE INTERIOR, Bureau of Land Management, Washington 25, D.C. Notice is hereby given that the SW¼SW¼ sec. 28, T. 31 S., R. 24 E., M.D.M., California, within the known geologic structure of the Buena Vista Hills Oil and Gas Field will be offered for oil and gas leasing through competitive bidding to the qualified bidder of the highest cash amount per acre at 1:00 p.m., E.S.T., May 12, 1954, when bids will be opened. Details of the lease offering, how and where to submit bids, and bid forms may be obtained upon request from the Manager of the Land and Survey Office, Sacramento, California, or from the Bureau's Washington Office. L. E. Hoffman, Chief, Division of Minerals.

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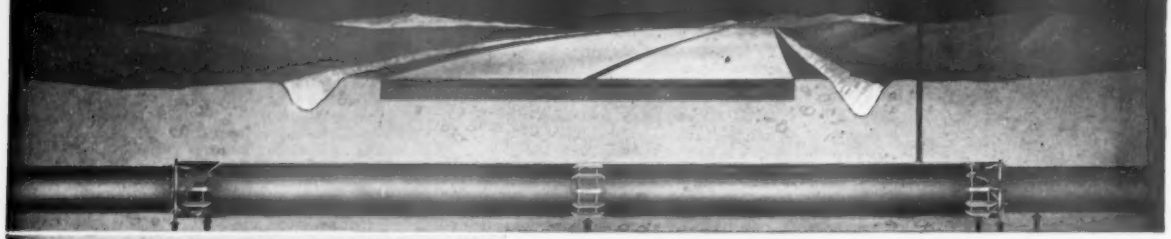

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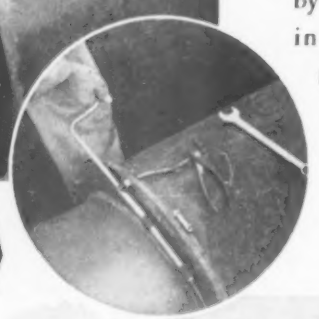

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It is Wyatt's policy to maintain financial structure to match its plant structure. This surplus item in the assets column is in reality just another working tool.

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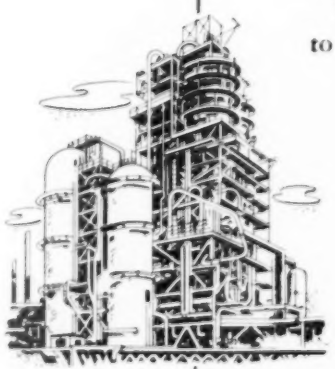
Putting some of the profit back in the business also gives a lift to employment, since men go to work as dollars go to work.



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